Scenario of Plant Biodiversity Conservation in Kashmir: An Overview

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Abstract

Biodiversity, or biological diversity, is variety of all species on earth. It is the different plants, animals and micro-organisms, their genes, and the terrestrial, marine and freshwater ecosystems of which they are a part. Biodiversity is both essential for our existence and intrinsically valuable in its own right because biodiversity provides the fundamental building blocks for the many goods and services a healthy environment provides. Looking after our biodiversity is therefore an important task for all people. The Kashmir Himalaya is rich in the cultural diversity of people, as well as diversity of flora and fauna in the forest areas and domesticated species outside forest. A number of valuable medicinal plants are present in Kashmir Himalaya but due to various anthropogenic activities they are becoming limited day by day. Despite efforts to manage threats and pressures to plant biodiversity in Kashmir Himalaya, it is still in decline. This is an attempt to document the status and major threats to the plant biodiversity in the Kashmir Himalaya, as well as deals with the various conservation strategies to manage and protect the plants of Kashmir.

The Union territory of Jammu and Kashmir; with a total reporting area of Kashmir Himalaya represents the main Valley of Kashmir together with the side-valleys of Tilul, Guraiz, Keran, and Karnah. The region falls within the bio-geographic zone of the North-Western Himalaya in India⁹. It lies between 33° 202 to 34° 542 N Latitudes and 73° 552 to 75° 352 E Longitudes, covering an area of 15948 sq. km. The Valley of Kashmir is elliptical and bowl-shaped, surrounded on all sides by high mountain ranges; the Middle or the Lesser Himalaya, called as the Pir Panjal Range, in the south and southwest separates the Valley from the Jammu region, while the Great Himalayan Range in the north and east separates it from the Ladakh region (Figure 1).

The vegetation of Kashmir represents appreciably diverse types owing mainly to habitat diversity. Two main types of natural ecosystems occur: terrestrial and aquatic. The terrestrial ecosystems form the major proportion of the landscapes. Beginning from some lowland subtropical vegetation types, these range from various domesticated plant systems in the main Valley, through subalpine to alpine floristic elements higher up in the mountains. The Kashmir region has the highest forest cover (about 51% of its geographical area) in



Figure1. Map of Jammu & Kashmir showing Kashmir Valley

Jammu and Kashmir State. The temperate forests occur between 1600 - 2700 m and comprise usually the conifers, such as Blue Pine (*Pinus wallichiana*), Himalayan Deodar (*Cedrus deodara*), Silver Fir (*Abies pindrow*), Spruce (*Picea smithiana*) and the Himalayan Yew (*Taxus wallichiana*), with some associated broad-leaved trees and shrubs. In the subalpine forests (2700 - 3500 m), the Silver Fir assumes dominance in the lower reaches, while natural stands of Birch (*Betula utilis*) occur above 3200 m, forming the timberline in the Kashmir Himalaya. Beyond the tree line, alpine scrub vegetation – comprising mainly the species of *Juniperus*, *Rhododendron*, *Salix*, *Lonicera*, *and Cotoneaster* – is quite common. The mountains at the subalpine and alpine altitudes are also dotted with the lush green meadows ('Bahaks') with characteristic herbaceous elements, such as species of *Aconitum*, *Artimisia*, *Atropa*, *Aquilegia*, *Bergenia*, *Gentiana*, *Pedicularis*, *Podophyllum*, *Ranunculus*, *Iris*, *Potentilla* etc. The aquatic vegetation abounds in a variety of habitats, including lakes, wetlands, marshes, swamps, rivers, hill streams, and springs. The lakes occur from the bed of the valley to the alpine zone and are usually classified as Valley, Forest, and Glacial Lakes. All these freshwater habitats, except the alpine lakes, support a wide array of vegetation, including various forms of hydrophytes, rushes, sedges, and reeds.

The present study is the review of existing information on the plant biodiversity of the region. For nomenclature and nativity of the species Dar and Dar¹ and Dar and Samant⁵ were followed. Endemism of the species was identified based on biogeographical distribution.

It was found that a total of 2312 species

(table-1) belonging to the 'land plants' bryophytes, pteridophytes, gymnosperms, and angiosperms from the region³. In all, these species are grouped under 842 genera and 189 families. As very few floristic studies have been carried out on the lower plant groups, such as bryophytes and pteridophytes, the number of species reported in these groups from the region is expectedly low. Among liverworts, largest genera are Plagiochila, Porella, Marchantia, and Riccia. Ricciocarpus natans, a floating liverwort is now rare. Among mosses, largest genera are Brachythecium, Bryum, Orthotrichum, Funaria, and Grimmia. Among pteridophytes, Pteridaceae is the largest family, followed by Aspleniaceae. The larger pteridophyta genera are Athyrium, Dryopteris, Asplenium, Cheilanthes, and Polystichum.

S.No.	Taxonomic group	Families	Genera	No. of sps.
1	Bryophytes	41	95	210
2	Pterdiophytes	12	29	90
3	Gymnosperms	04	08	12
4	Angiosperms	132	710	2000
5	Total	189	842	2312

Table-1. Floristic diversity of various taxonomic groups in Kashmir

Although only some gymnosperm species are growing as wild, yet they constitute the dominant floristic elements in the coniferous forests of the region. Because of the lesser number of species in gymnosperms, species richness in this group is well-documented from the region². A prodigious single tree of the giant sequoia (*Sequoiadendron giganteum*) growing at Yarikhah (Tangmarg, Gulmarg) in Kashmir Valley is the lone representative of this State Tree of California in the India

subcontinent. As is true for other regions all over the world, angiosperms represent the most species of plants, with about 2000 species reported from the region. Based on the number of species, the first ten large families of angiosperms in Kashmir are shown in Table 2. Fifty-five percent of the total species is contributed by these ten families only. Sixtyone families are mono-generic, thirty-four of which are monotypic in this region.

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S. No	Family	No. of genera	No. of sps.
1	Asteraceae	72	260
2	Poaceae	73	160
3	Brassicaceae	44	115
4	Rosaceae	32	98
5	Lamiaceae	32	88
6	Fabaceae	34	84
7	Cyperaceae	09	81
8	Scrophulariaceae	19	77
9	Ranunculaceae	17	70
10	Apiaceae	37	68

Table-2. The first ten large families of angiosperms in Kashmir

Endemic Flora:

Endemism is a term applied to those taxa that are restricted to a specified geographical area or ecological unit. In our country, the maximum endemism is found in Northeast India, followed by southern parts of Peninsular India and the Northwestern Himalaya. According to Dar *et al.*², 153 (8%) angiosperm taxa found in Kashmir are endemic exclusively to this region. The extent of narrowly endemic species richness in the Kashmir Himalaya reveals that although this region represents only 0.48% of the total land area of India, it supports about 12% of the country's total angiosperm flora and about 3% of its endemics. Area-wise, the Kashmir Himalaya

has one endemic taxon per 104 sq. km as against per 186, 609 and 757 sq. km, respectively, in the Himalaya, India, and Ladakh (table-3).

Medicinal and aromatic flora:

Recently, Dar and Dar¹, revealed that about 17% of the flora in Kashmir Himalaya has known or potential medicinal value. Most of the medicinal and aromatic plant species (MAPS) belong to the dicotyledons (Table-4 and 5); the Asteraceae having the highest number of MAPS followed by Ranunculaceae, Lamiaceae, Apiaceae and Scrophulariaceae (Table-5).

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S.No.	Familiy	No. of endemic species
1	Asteraceae	21
2	Brassicaceae	17
3	Rosaceae	11
4	Fabaceae	9
5	Scrophulariaceae	9
6	Gentianaceae	8

Table-3. Families with a large number of endemic species in Kashmir

S.No.	Plant group	Families	Genera	No. of Sps.
1	Dicotyledons	79	239	400
2	Monocotyledons	13	28	37
3	Gymnosperms	5	4	7
4	Pterdiophytes	5	5	6
	Total	101	276	450

Table-4. A numerical summary of the medicinal and aromatic flora in Kashmir

Source Dar et al. 2006

Table-5. First ten families with a larger number of medicinal plants in Kashmir

S.No.	Name of family	Total no. of Sps.	No. of MAPS*
1	Asteraceae	260	55
2	Ranunculaceae	70	33
3	Lamiaceae	88	31
4	Apiaceae	68	19
5	Scrophulariaceae	77	17
6	Brassicaceae	115	16
7	Papilionaceae	84	16
8	Rosaceae	98	16
9	Polygonaceae	52	15
10	Gentianaceae	50	11

* MAPS = Medicinal and aromatic plant species

Floristic diversity in red in Kashmir:

In Kashmir Himalaya a number of medicinal plants like Atropa acuminata, Artemisia amygdalina, Arnebia benthamii, Abies pindrow, Bergenia ligulata, Cedrus deodara, Lavetera cashmeriana, Oxalis corniculata, Podophyllum hexandrum, Sassurea costus, Trillium govanianum etc. are found in different forest sites and are being used continuously for the treatment of various ailments of human beings and other animal diseases by the local indigenous people of the region. Mostly these people live in close vicinity to forests and collect a number of herbaceous medicinal plants from the nearby forests and used their parts like roots, leaves, etc for the treatment of various human diseases and also sell them to other people of the region. There is also a great demand for these medicinal plants and their parts by pharmaceutical companies to prepare different herbal medicines from them. The demand for these medicinal plants is increasing day by day and they become limited with each passing day. Out of 355 plant species (Table-6) recognized by Dar and Nagshi³ in Kashmir under different threatened categories, 282 species belong to the dicotyledons and 73 species to monocotyledons. The angiosperms have been considered only by them, that to using the pre - 1994 IUCN Threat Categories. Hence, in

the future, the lower plants need to be evaluated with reference to their threat status. Based on their endemicity and rate of deforestation, the Trans- and Kashmir Himalaya are together considered as one of the 28 centers of endemic plant diversity in India. About 10% of the flowering plants are considered as threatened. The endemic plants are generally prone to threat because of their rarity and ecosystem/ habitat specialization. It is estimated that 40% of our endemic plant species are endangered. Some of the threatened plant species may already be extirpated as they have not been collected from the Kashmir Himalaya during the last 50 years or more (Table-7). Of the various factors responsible for the loss of biodiversity world over, the Kashmir Himalayan flora is faced with the major threats like habitat loss and fragmentation, encroachment and degradation of forest and freshwater ecosystems, indiscriminate and uncontrolled grazing in alpine and subalpine meadowlands is beyond their carrying capacity, biological invasions, over-harvesting, and overexploitation of plant biodiversity, Dwindling/loss of locally domesticated plants and ecologically insensitive economic development.

 Table-6
 Plant species under different threat categories in the Kashmir Himalaya

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S.No.	Threat category	No. of sps.
1	Endangered	40
2	Vulnerable	50
3	Rare	155
4	Indeterminate	110
	Total	355

Table-7 Plants reported from the Kashmir Himalaya but not collected during the last 50 Years or more

S. No.	Name of species	Family
1	Arcyosperma primulifolium (Toms.) Schulz	Brassicaceae
2	Berberis calliobotrys Aitch ex Koehne	Brassicaceae
3	Celtis tetrandra Roxb.	Ulmaceae
4	Cicuta virosa L.	Apiaceae
5	Impatiens pahalgamensis Hook. f.	Balsaminaceae
6	Pedicularis hoffmeisteri Klotzch	Scrophulariaceae
7	Petrohagia alpina (Habl.) P.W. Ball & Heywood	Caryophyllaceae
8	Primula clarkei G. Watt.	Primulaceae
9	Pseudomertensia drummondii	Boraginaceae
10	Verbascm blattaria L.	Scrophularaiceae

The major reasons for extinction of plant biodiversity in Kashmir Himalaya have been explored as follow.

Destruction of habitat: The natural habitat may be destroyed by man for his settlement, grazing grounds, agriculture, mining, industries, highway construction, drainage, dam building, etc. as a consequence of this; the species must adapt to the changes, move elsewhere or may succumb to predation, starvation or disease and eventually die.

Hunting: From time immemorial, man has hunted for food. Commercially, wild plants are used for medicinal products for the treatment for various diseases by local people of the region.

Over exploitation: This is one of the main causes of the loss of not only economic species but also biological cariosities like the insectivorous and primitive species and other taxa needed for teaching or laboratory (like Nepenthense, etc.). Commercial exploitation of wild plants has invariably causes their overuse and eventual destruction for cosmetics and decoration purposes.

Biodiversity conservation strategies:

By adopting the following laws strictly the biodiversity of the region should be conserved to a greater extent. J & K Wildlife (Protection) Act 1978. Forest (Conservation) Act 1972, 1997 & 1980.

Jammu and Kashmir biological diversity Act, 2002, 2015.

In-situ conservation:

At present, the J&K State comprises

one (proposed) Biosphere Reserve, 4 National Parks and 15 Wildlife Sanctuaries for the insitu conservation of biological diversity. These protected areas cover different altitudinal zones ranging from tropical to alpine. Notifications of these protected areas are helping largely in the in-situ conservation of threatened and economically important plants. Besides these protected areas, there are a large number of Reserve Forests and unprotected areas located at different elevations to help in the in-situ conservation. At present, fragmentary information is available on the various aspects (including diversity, geographical distribution, utilization pattern, and folklore information) of threatened plants in the state. Therefore, there is an urgent need to identify the areas (protected and unprotected) and notify rich areas as Economically Important Plant Conservation Zones (EIPAZs) at different altitudinal zones with the participation of the native communities and the various organizations (State, Central and NGOs).

Ex-situ conservation:

Like other Indian Himalayan states, Jammu and Kashmir is also considered as Herbal State. Being a herbal state, development of conservation repository like herbal gardens, medicinal plant nurseries and cultivation in the farmer's field of threatened plants has been promoted to some extent but not as much as required. Various organizations are involved in the conservation of threatened/economically important plants. The list of Governmental and nongovernmental organizations involved in the ex-situ conservation of threatened and economically important plants are given below.

Government Organizations:

Centre for Biodiversity, Studies, Baba Ghulam Shah Badshah University, Rajouri, J&K

Defence Institute of High Altitude Research, Leh, J&K

Medicinal plants introduction centre Pampore. Indian Institute of Integrative Medicine (formerly RRL), J&K

SKAUST Jammu and Kashmir (including all regional research stations)

Sri Mata Vaishno Devi University, Katra, State Forest Research Institute, J&K University of Jammu, Jammu, J&K University of Kashmir, Srinagar, J&K

Non Governmental Organizations:

NOMAD, Leh, J&K

WWF-India, Jammu & Kashmir (including regional offices)

Pragya, Field office, Leh, J&K.

Conservation technology of threatened plants:

Conservation technology of threatened plants in general, amongst the threatened and economically important plants, conservation technology i.e., in-vitro and agro technology of Saussurea costus, Angelica glauca, Dioscorea deltoidea, Allium stracheyi, Dactylorhiza hatagirea, Podophyllum hexandrum, Rheum emodi, Taxus baccata subsp. wallichiana, Aconitum heterophyllum, Zanthoxylum armatum, Valeriana jatamansi, Picrorhiza kurrooa, etc. are known. Still, there are many other commercially viable threatened/ economically important plants whose conservation technologies are yet to be standardized. Development of conservation technologies of threatened/economically important plants will not only help in promoting mass cultivation in farmers fields but also, help in reducing pressure on wild stock. In Jammu and Kashmir, various organizations such as Indian Institute of Integrative Medicine, Jammu (formerly known as RRL, Jammu), University of Jammu, Jammu, Centre for Biodiversity Studies, BGSB University, Rajouri, University of Kashmir, Srignar, Sher-a-Kashmir Agriculture University of Science and Technology, Jammu and Srinagar, State forest Research Institute, J&K, Defence Institute of High Altitude Research, Leh and Shree Mata Vaishno Devi University, Jammu are actively engaged in developing conservation technologies for these species.

This paper provides comprehensive information on plant biodiversity of the region. The study shows that more than 77% species are native, 26% are near-endemic and 0.015% are endemic to this region and also indicates the importance of their conservation. Further, most of the threatened plants are used in pharmaceutical industries and in Ayurvedic, Unani and Tibetan system of medicine^{7,8}. They are also used in folklore/traditional way. According to the All India Trade Survey of prioritized medicinal plants, demand of some high-value medicinal plants has increased 50%, whereas availability has declined by 26%. The ever-increasing demand of these species in the both pharmaceutical industries and in traditional system has resulted in habitat degradation and overexploitation. If overexploitation of these plants continues, many species may decrease in, and ultimately disappear from their natural habitats. This applies particularly to economically important plants with multiple uses. Moreover the present study has only

focused on the threatened plants of the J&K but many other species also faces high degree of pressures, calls an urgent need for adequate conservation and management. To achieve the goals, a collaborative work plan has to be prepared involving various stakeholders i.e., scientists, technocrats, government organizations, NGOs and farmers to implement the rule of section 8 of Biodiversity Act 2002, i.e., conservation of biological diversity, sustainable use of its components and fair and equitable sharing of benefits arising out of the use of biological resources and knowledge to meet out the market demands and conservation of threatened and economically important plant biodiversity of the region as well as India.

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