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Floristic Diversity in the Kashmir Himalaya: Progress, Problems and Prospects

(Kepelbagaian Flora di Himalaya Kashmir: Kemajuan, Masalah dan Prospek)

G.H. Dar* & A.A. Khuroo

ABSTRACT

The Kashmir Himalaya, being nestled within north-western folds of the Himalaya, harbours a rich floristic diversity of immense scientific interest and enormous economic potential. Though scientific studies on the floristic diversity in the Kashmir Himalaya have been started about two centuries ago, yet they fall short of the requirements needed urgently in the post-Rio Summit. In fact, at the spatial scale, many far flung areas and difficult terrains in the hinterland are still either least- or totally-unexplored; and at the taxon scale, floristic studies especially with regard to the lower plants are insufficient, thus posing serious problems in assessing the floristic diversity in the region. With such a perspective in hindsight, the present paper dilates upon the progress achieved so far, highlights the problems being faced and envisages the future prospects with regard to floristic diversity in this region. First, a broad overview of the current status of floristic diversity in this Himalayan region is presented, followed by a critical analysis of the knowledge base presently available on various taxonomic groups of plants. The yawing gaps in our knowledge of floristic diversity in this region are identified and an action plan to bridge these gaps is also outlined. Hopefully, addressing these challenges in the immediate future could facilitate the documentation, conservation and sustainable use of plant resources in this region, so as to steer this 'Himalayan Paradise' towards the path of sustainable development.

Keywords: Conservation; documentation; floristic diversity; Kashmir Himalaya; sustainable use

ABSTRAK

Himalaya Kashmir terletak di kawasan barat laut Himalaya, mengandungi suatu kepelbagaian flora yang kaya yang diminati secara saintifik dan potensi ekonomi yang tinggi. Walaupun kajian saintifik ke atas kepelbagaian flora di Himalaya Kashmir telah dimulakan lebih kurang dua abad yang lalu, tetapi ia masih berada di tahap rendah dan perlu perhatian segera selepas pasca Kemuncak Rio. Pada skala reruang, banyak kawasan yang jauh dan curam yang sukar di kawasan pedalaman masih berada sama ada di tahap paling kurang atau tidak langsung dijelajahi; dan pada skala takson, kajian flora khususnya tumbuhan rendah adalah sangat tidak memadai, justeru memberi masalah serius dalam penaksiran kepelbagaian flora di rantau itu. Dengan perspektif sedemikian, kertas ini membincangkan kemajuan yang dicapai kini, mengutarakan masalah yang ditemui dan mengandaikan prospek masa depan berkenaan dengan kepelbagaian flora di rantau ini. Pertama, suatu penilaian secara umum mengenai status terkini kepelbagaian flora di rantau Himalaya telah dipersembahkan, diikuti oleh analisis kritikal ke atas pangkalan pengetahuan yang tersedia bagi kepelbagaian kumpulan taksonomi tumbuhan. Luang yang jelas di dalam pengetahuan kita mengenai kepelbagaian flora di rantau ini telah dikenal pasti dan suatu pelan tindakan untuk mengurangkan jurang ini telah digariskan. Adalah diharapkan dengan mengutarakan cabaran ini untuk masa depan membolehkan pendokumentasian, pemuliharaan dan penglestarian sumber tumbuhan di rantau ini agar ia dapat memacu 'Syurga Himalaya' ke arah pembangunan lestari.

Kata kunci: Himalaya Kashmir; kepelbagaian flora; pemuliharaan; pendokumentasian; penggunaan lestari

Introduction

The Kashmir Himalaya is well-known for its scenic beauty throughout the world; it has been aptly referred to as a 'Terrestrial Paradise' on the Earth (Vigne 1842). One of the chief features contributing to the global fame of Kashmir is the rich biodiversity that adorns its captivating landscape (Lawrence 1895). Being phytogeographically located at the intersection of Holarctic and Paleotropical Floristic Realms and falling within the North-Western Himalaya, the region is endowed with teeming treasure-troves of plant diversity. It represents a unique bio-region owing primarily to its varied topography and habitat heterogeneity along a wide elevational range.

As supported by the geological evidences (Puri 1943, 1947; Vishnu-Mittre 1963), the Kashmir Himalayan flora, to begin with, is believed to have been typically a tropical one; and in the aftermath of Little Ice Age, it was transformed into a mosaic of subtropical-temperate-alpine

flora. With the passage of time, the floristic elements from far and wide have found entry into this region, either through natural dispersal mechanisms or by human agency; hence its extant flora is largely an admixture of neighbouring phytogeographical regions with reasonably a good proportion of endemics.

Over the last two centuries, starting from the first recorded botanical collection of William Moorecroft, a non-botanist, in 1822 up to the present time, numerous workers have explored and documented the plant wealth growing along a variety of topographical and elevational gradients throughout this region (Stewart 1979). Notwithstanding these praiseworthy contributions, compilation of a modern and to some extent complete treatise exclusively on the plant diversity of the region has assumed pressing priority, especially in the post-Rio Summit World (Dar & Farooq 1997; Heywood 1995; Wilson 2003). It is a formidable, but achievable task before the researchers that has far-reaching applications for the academics, resource managers, policy makers and the general public (Khuroo et al. 2007).

Based on our own work during the past three decades and supplemented with those of the previous workers (Dhar & Kachroo 1983; Kaul 1986, 1997; Singh & Kachroo 1976, 1994; Stewart 1972), the present paper attempts a broad retrospective stocktaking of the progress made in assessment and documentation of floristic diversity in the Kashmir Himalaya. Firstly, the paper outlines a brief sketch of the habitat diversity and the vegetation profile. This is followed by summarization of the available knowledge base about the floristic diversity, more specifically the plant species richness in different taxonomic groups. Other important aspects, such as phytogeography, endemics, medicinal, threatened and alien plant taxa, are also discussed because of their wide implications for the conservation and sustainable use of floristic diversity in this Himalayan region. In spite of the progress achieved so far, the paper highlights various problems that are main impediments in the way forward. Lastly, looking ahead, the synthesis suggests the steps that need to be taken urgently for maximizing the prospective benefits which will accrue from the sustainable use of the floristic diversity in the region.

Study Area

In the present paper, the Kashmir Himalaya represents the main Valley of Kashmir together with the side-valleys of Tilel, Guraiz, Keran and Karnah. The region falls within the biogeographic zone of the North-Western Himalaya in India (Rodgers & Panwar 1988). It lies between 33° 20′ to 34° 54′ N Latitudes and 73° 55′ to 75° 35′ 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 altitude of the main valley itself ranges from 1500 m to 1800 m (amsl), whereas the average height of its surrounding mountain ranges varies from 3000 to 4000 m, the highest peak being Kolahoi (5420 m).

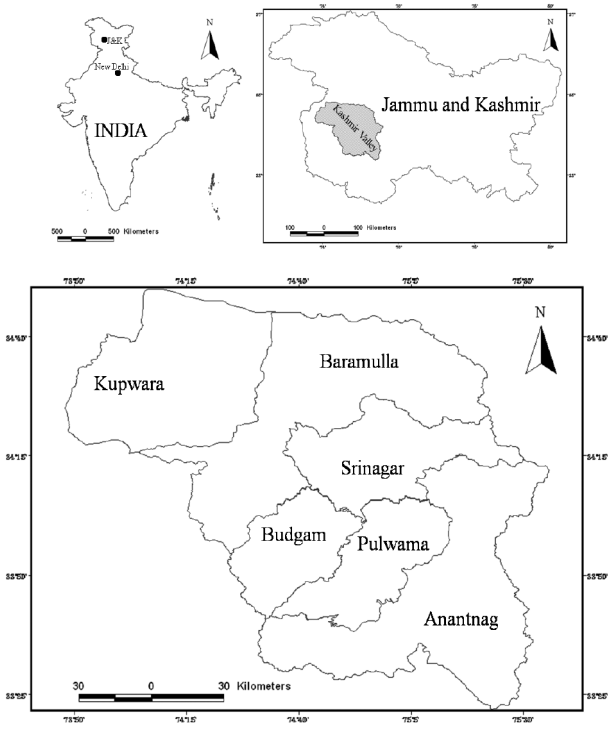

FIGURE 1. Map of Jammu & Kashmir showing Kashmir Valley

Flowing through the heart of the Valley is the river Jhelum, which has many tributaries and forms the main source of irrigation in this region. The Valley shows considerable topographical, altitudinal and climatic variation, resulting in great habitat diversity: lakes, rivers and nullahs, springs, floating gardens, marshes and swamps, cultivated fields and orchards, plantation sites, graveyards, roadsides, wastelands, Karewa lands, forest lands, gravel and rocky mountain slopes, subalpine and alpine meadowlands and permanent glaciers. The climate is predominantly temperate with wet and cold winters and relatively dry and hot summers. It is marked by well-defined seasonality, with four seasons a year: winter (December-February), spring (March-May), summer (June-August) and autumn (September-November) (Husain 2001).

Stocktaking: A Retrospective Overview

Habitat diversity

One of the important factors responsible for a diverse floristic wealth in the region is the habitat heterogeneity - both terrestrial and aquatic ones. Broadly, two major zones can be recognized.

The Valley Zone It comprises the main valley basin, including the *Karewa* mounds falling within the elevation range of 1300-1800 m. On the basis of whether these habitats are the result of human activities or naturally occurring, the Valley Zone can be further subdivided into artificial and natural habitats, respectively.

The Montane Zone It comprises the hillocks and mountains surrounding the main valley and side-valleys, including the forests and meadows largely above the elevation of 1800 m. This zone, being less or not populated, more so in the upper reaches, harbors a relatively good proportion of endemic plants in the subalpine and alpines sites (Table 1).

Vegetation types: A profile

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 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 (Figure 2). 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*, *Aquilegia*, *Gentiana*, *Pedicularis*, *Ranunculus*, *Iris* and *Potentilla*.

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.

Current status of the Kashmir Himalayan flora

At the present stage of investigation, a total of 2312 species belonging to the 'land plants' – bryophytes, pteridophytes,

TABLE 1. A brief outline of habitat diversity in the Kashmir Himalaya

Valley Zone (1300-1800 m)		Montane Zone (> 1800 m)
Artificial habitats	Natural habitats	Montane streams and nullas
		Montane slopes
Habitation sites	Riverine sites	Montane lakes
Plantation sites	Valley lakes	Forestlands
Cultivated fields	Wetlands	Temperate (1600-2700 m)
Orchards	Springs and canals	Subalpine (2700-3500 m)
Mud-/Masonry walls	Karewa mounds	Alpine (> 3500 m)
Roadsides/ Railway tracks	Grasslands	Meadowlands
	Wastelands	Subalpine
	Graveyards	Alpine
		Glacier sites
		Alpine glacial lakes
		Alpine rocky and scree slopes

(*Source*: Dar & Christensen 1999)

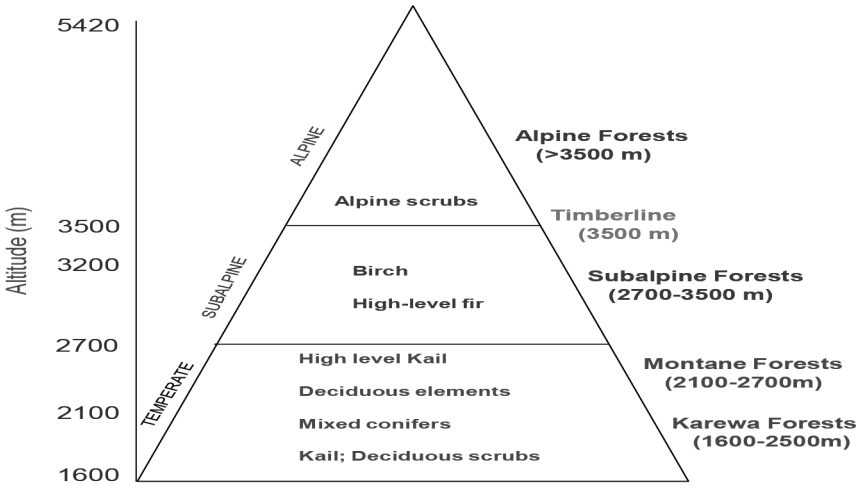

FIGURE 2. Generalized altitudinal zonation of forests in Kashmir

gymnosperms and angiosperms – have been recorded from the region (Table 2). 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 pteridophyte genera are: *Athyrium, Dryopteris, Asplenium, Cheilanthus* and *Polystichum*.

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 region (Dar & Dar 2006). 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 (Figure 3).

As is true for other regions all over the world, angiosperms represent the most speciose group of plants, with about 2000 species reported from the region. Based on the number of species, the first ten large families of

FIGURE 3. *Sequoiadendron giganteum* in Kashmir

angiosperms in Kashmir are shown in the Table 3. Fifty five percent of the total species is contributed by these ten families only. Sixty one families are mono-generic, thirty four of which are monotypic in this region.

The first ten large genera in the region are shown in Table 4. Thirty four genera contain ten or more species each and account for ca. 27% of the total species. The proportion of genera to species is 1:2.8 as against 1:4.3 in India.

TABLE 2. Floristic diversity of various taxonomic groups in Kashmir

Taxonomic group	Number of		
	families	genera	species
Bryophytes	41	95	210
Pteridophytes	12	29	90
Gymnosperms	04	08	12
Angiosperms	132	710	2000
Total	189	842	2312

(*Source*: Dar et al. 2002)

PHYTOGEOGRAPHICAL AFFINITIES

The flora of Kashmir Valley is said to have been the typical Himalayan or the Sino-Japanese during the Pleistocene. The geological and climatic changes which occurred thereafter have led to replacement of the original tropical flora by subtropical and finally by temperate types. The present flora of Kashmir is Holarctic with elements belonging to two subkingdoms–Boreal and Tethyan; the former being represented by the Circumboreal, Eurasian and the Eastern Asiatic regions; and the latter by the Mediterranean and the Iran-Turanian regions. A phytogeographical analysis reveals that the angiosperm flora of Kashmir contains the following main floristic elements: Circumboreal, European-North Asiatic, Eastern Asiatic (Sino-Japanese), Mediterranean, Western Asiatic and Central Asiatic. Regarding the affinity of Kashmir Himalayan flora with those of the neighbouring areas, it is the greatest with the northern Pakistan and Western Himalaya, but progressively decreases with Afghanistan, Central Asia, China, Eastern Himalaya, Europe, Tibet and Iran (Dhar & Kachroo 1983) (Figure 4).

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 the Northeast India, followed by southern parts of the Peninsular India and the Northwestern Himalaya. According to Dar et al. (2012), 153 (ca. 8%) angiosperm taxa found in Kashmir are endemic exclusively to this region. The extent of narrow 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

TABLE 3. The first ten large families of angiosperms in Kashmir

No.	Family	Number of	
		genera	species
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 4. The first ten large genera of angiosperms in Kashmir

No.	Genus	Number of species	No.	Genus	Number of species
1.	*Carex*	36	6.	*Nepeta*	20
2.	*Taraxacum*	35	7.	*Ranunculus*	19
3.	*Polygonum* s.l.	25	8.	*Veronica*	19
4.	*Potentilla*	22	9.	*Gentiana*	18
5.	*Artemisia*	20	10.	*Pedicularis*	18

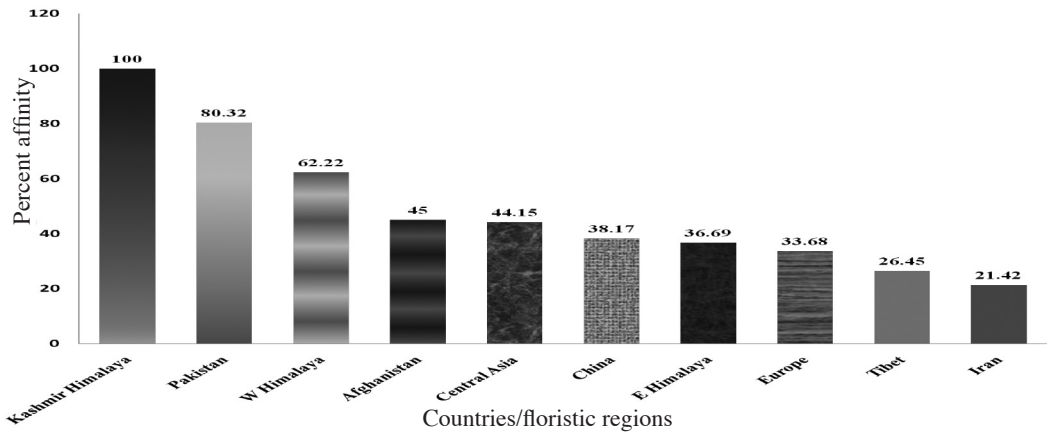

FIGURE 4. Phytogeographical affinity of the Kashmir Himalayan flora

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 5).

The families with larger number of endemic species in Kashmir are shown in Table 6.

MEDICINAL AND AROMATIC FLORA

Recently, Dar et al. (2007) 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 7); the Asteraceae having the highest number of MAPS, followed by Ranunculaceae, Lamiaceae, Apiaceae and Scrophulariaceae (Table 8).

ARBOREAL FLORA

A significant component (ca. 15%) of the Kashmir flora comprises shrubs and trees. According to Ara et al. (1995) the overall arboreal flora in this region is represented by 295 species of trees and shrubs (both indigenous and exotics), distributed over 120 genera and 60 families. The families with larger number of wild arboreal species are Rosaceae and Caprifoliaceae. The genera with larger number of arboreal species include *Cotoneaster, Lonicera,*

TABLE 5. Endemic angiosperm plants in the Kashmir Valley with reference to adjoining regions and India

Region	Number of species recorded		Percentage of endemics to the total
	Total species	Endemic species	
Kashmir	2000	153	7.60
Ladakh	1174	74	6.30
Himalaya	8000	3200	40.00
India	17500	5400	30.85

(*Source*: Dar et al. 2012)

TABLE 6. Families with larger number of endemic species in Kashmir

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

TABLE 7. A numerical summary of the medicinal and aromatic flora in Kashmir

Plant groups	Number of		
	families	genera	species
Dicotyledons	79	239	400
Monocotyledons	13	28	37
Gymnosperms	4	4	7
Pteridophytes	5	5	6
Total	101	276	450

(*Source*: Dar et al. 2007)

TABLE 8. First ten families with larger number of medicinal plants in Kashmir

No.	Name of family	Total number of species	Number 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

Rubus, Berberis, Salix, Spiraea, Acer, Clematis, Prunus and *Rosa*. Oriental Plane/ 'Boin' (*Platanus orientalis*) *is* the State tree. Kashmir elm /'Bren' (*Ulmus wallichiana*), 'Shah Tul' (*Morus nigra*), Alder (*Alnus nitida*) and Hazel /'Virin' (*Corylus jacquemontii*) are now endangered in Kashmir Valley (Figure 5).

FIGURE 5. *Platanus orientalis* - State tree of Jammu & Kashmira

ALIEN FLORA

Khuroo et al. (2007) reported a total of 571 plant species, belonging to 352 genera in 104 families, as alien in the Kashmir Himalaya. These constitute about 29% of total flora of the region. Some notorious alien invasive species include: *Anthemis cotula*, *Xanthium strumarium*, *X. spinosum*, *Galinsoga parviflora*, *Cannabis sativa*, *Conyza canadensis*, *C. bonariensis*, *Salvinia natans*, *Ceratophyllum demersum* and *Potamogeton nodosus*, to name only a few. *Parthenium hysterophorus* and *Azolla cristata* are recently introduced tropical species into the Valley.

AGRO-BIODIVERSITY

Agriculture and Horticulture is the mainstay of more than 60% population in Kashmir. The major field crops in the Valley are rice, wheat, maize, mustard and barley. Some interesting food crops (pseudo-cereals) are occasionally grown in some hilly areas; these include: buckwheats (*Fagopyrum esculentum*, *F. tataricum*,), grain amaranths (*Amaranthus caudatus*, *A. hybridus*) and millets (*Panicum miliaceum* -'Pingha', *Setaria italica*-'Shol'). Saffron (*Crocus sativus*), the pride crop of Kashmir, is grown only in Kashmir Valley in the whole of South Asia. Kashmir is also known for its temperate rosaceous fruits – apple, pear, cherry, almond, peach, plum and apricot; as well as for walnut, grapes and pomegranate. The region is also rich in wild relatives of crop plants, including cereals (*Leersia oryzoides*, *Aegilops tauschii* - considered as one of the ancestors of bread wheat), legumes, fruits, vegetables, oil seeds, fibers, spices and condiments (Figure 6).

FIGURE 6. Saffron - *Crocus sativus* in Kashmir

FLORISTIC DIVERSITY IN 'RED'

Out of 355 plant species recognized by Dar and Naqshi (2002) under different threatened categories (Table 9), 282 species belong to the dicotyledons and 73 species to monocotyledons. In this study, only the angiosperms have been considered, that too using the pre-1994 IUCN Threat Categories. Hence, in 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 centres 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 ca. 40% of our endemic plant species are endangered (Dhar & Kachroo 1983). 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 10).

Of the various factors responsible for the loss of biodiversity worldover, the Kashmir Himalayan flora is faced with the following major threats:

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 over-exploitation of plant biodiversity; Dwindling/loss of local domesticated plants and Ecologically insensitive economic development.

TABLE 9. Plant species under different threat categories in the Kashmir Himalaya

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

(*Source*: Dar & Naqshi 2002)

TABLE 10. Plants reported from the Kashmir Himalaya but not collected during the last 50 years or more

No.	Name of species	Family
1.	*Arcyosperma primulifolim*	Brassicaceae
2.	*Berberis calliobotrys*	Berberidaceae
3.	*Celtis tetrandra*	Ulmaceae
4.	*Cicuta virosa*	Apiaceae
5.	*Impatiens pahalgamensis*	Balsaminaceae
6.	*Pedicularis hoffmeisteri*	Scrophulariaceae
7.	*Petrohagia alpina*	Caryophyllaceae
8.	*Primula clarkei*	Primulaceae
9.	*Pseudomertensia drummondii*	Boraginaceae
10.	*Verbascum blattaria*	Scrophularaiceae

Present Problems

In the post-Rio Summit World, our knowledge about what, where and how to measure, monitor, minimize and manage the threats to biodiversity is abysmally inadequate. A clear 'taxonomic deficit' in the theoretical and practical aspects of biodiversity science is recognized, especially in the developing countries. In the Kashmir Himalaya, impediments that roadblock our march towards the development of regional biodiversity infrastructure are summarized as below.

Written records of plant explorations in the Kashmir Himalaya date back to about two centuries, but its complete up-to-date flora as needed in the post-CBD era is still awaited. In the case of viruses, bacteria, algae, fungi, lichens, mosses and ferns, we lack even the preliminary inventories; Because of incomplete survey, many areas in the region are either un- or under-explored; Whatever information is available on biodiversity of the region is frustratingly scattered and mostly inaccessible; Paucity of revisionary and monographic studies on taxonomically large and complex genera, such as *Carex*, *Poa*, *Festuca*, *Artemisia*, *Potentilla*, *Nepeta*, *Ranunculus*, *Astragalus*, *Euphrasia*, *Salix*, *Saussurea*, *Taraxacum*, *Veronica*, *Pedicularis* and *Corydalis*. has often led to confusion in their species delimitation; Non-existence of detailed vegetation mapping and species distribution data hamper our efforts in studying biodiversity at the community and ecosystem levels; Scarce information is available on the genetic diversity, particularly on the agro-biodiversity of the land races and wild relatives of cultivated plants; A shortfall is discernable in the systematic understanding of Red Listed species as well as endemics. For instance, out of 355 species of angiosperms listed under threatened categories, 110 are indeterminate (data-deficient), thereby limiting the efforts to evaluate their real threat status (Dar & Naqshi 2002); There is a dearth of institutional infrastructure for biodiversity studies in the region. Also, inadequate funding is available to the local workers; We believe that the biodiversity is more an issue of social concern rather than just a topic of academic interest. In this regard, an unproductive dichotomy between academia and public policy makers in the region is presently proving to be a stumbling block and finally but unfortunately, taxonomists in the Kashmir Himalaya are a few, but the tasks before them are gigantic.

Future Prospects

Review of the progress achieved so far on floristic diversity in the Kashmir Himalaya and identification of the knowledge gaps will help us in filling the taxonomic deficit. For instance, on perusal of many scattered publications, Dar et al. (1995) could reveal that 184 new records/new taxa of angiosperms have been described from the Kashmir Himalaya during the period of 1970-1992. Taking a leaf out of it, it is believed that once knowledge gaps are filled, a biodiversity information infrastructure can be established, with tools and protocols to detect changing trends in biodiversity, identification of the impending threats and the development of sound conservation strategies. However, at present, due to our insufficient knowledge base, the first and foremost task would be to inventorize and document the biodiversity of this region.

Short-term rapid assessment For this, well-studied taxonomic groups can be used as surrogates. On a priority basis, integrative biological studies of threatened species and ecosystems are urgently warranted;

Long-term assessment To complete the discovery, inventorization and documentation of overall flora in this region, with an equal emphasis on all the taxonomic groups, intensive regional biodiversity surveys need to be undertaken. Usually less stress is laid on lower groups of plants; for instance, many algal and bryophytic records from Kashmir are not validated by voucher specimens, thus making their authenticity doubtful;

Data-basing alone is not sufficient The compilation of data-base on biodiversity *per se* would be inadequate for meeting the challenges ahead. Therefore, the usefulness of data-base can be widened by supplementing the information on intra-specific diversity, exact location and distribution ranges of taxa, their abundance, reproductive efficiency and regeneration potential;

Comprehensive studies on threatened species Comprehensive studies on rare, endemic and threatened (RET) plants will help in assigning them authentic threat status based on the latest IUCN regional guidelines, in particular the ground-truthing by field biologists. Stress should be laid on continuous and improved sampling to monitor temporal changes in the threatened taxa;

Preservation of agro-biodiversity Since the release of handful of high-yielding varieties (HYVs) of crops, scores of land races have disappeared from the field and many of these are not even preserved in the gene banks. More importantly, the wild relatives of crop plants – a valuable genetic reservoir – are of immediate conservation concern. Also, there is a need to preserve as much genetic diversity of each crop species as possible. Some of the indigenous crop cultivars are culturally very precious and need to be immediately attended to; for example, 'Gulzag', 'Lulanzun', 'Kathwor', 'Mushkbabur/'Mushkbudij', 'Goda Kruhun' and 'Qadir Ganai', once grown in Kashmir as cherished cultivars of rice for their scent, taste and colour, are rarely cultivated nowadays;

Bioprospecting of biodiversity Traditional uses of plant species, such as medicinal and aromatic plants (MAPs), as well as all other economically important taxa, need to be documented. Commercial exploitation of these plant resources should be based on equal stake holding;

Regional Biodiversity Action Plan As a step towards base-line, handy documentation of our valuable plant resources for use by all the concerned agencies, there is a need for the development of a regional strategy and action plan for biodiversity;

Mass awareness Humans are a part of the natural world and must be included in the conservation actions. Public awareness and education on issues concerning to biodiversity need to be kick-started as a full-fledged campaign on 'Bio-literacy' throughout the region, using both electronic and print media;

Public policy making Public-private partnership (3Ps) and Institution-industry interface (3Is) in biodiversity conservation can be the pragmatic approach for successfully attaining the sustainable use of biodiversity. Legal and administrative measures concerning biodiversity can be translated into action only with the de-bureaucratization of environmental policy making;

Supportive measures In the recent times, trans-disciplinary approach in research is advocated for cross-fertilization of ideas between the natural and social scientists. Need of the hour is to forge this collaboration in order to estimate the economic values of biodiversity and

Capacity building and institutional support The State and Central agencies are expected to strengthen the institutions involved with study of floristic diversity in the region. We believe the institutions, such as Centre for Biodiversity and Taxonomy (CBT) and Kashmir University Botanical Garden (KUBG) provide the basic infrastructure to house the precious herbarium specimens and living collections of plants under *ex situ* germplasm banking, respectively. Research work carried out at these institutions in the past, as also being done at present and to be carried in future, holds great promise to fill the gaps in our knowledge of the Kashmir Himalayan floristic diversity.

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G.H. Dar*
Mahatma Gandhi Chair on Ecology & Environment
Baba Ghulam Shah Badshah University
Centre for Biodiversity Studies
Rajouri-185 234, Jammu & Kashmir
India

A.A. Khuroo
Centre for Biodiversity & Plant Taxonomy
University of Kashmir
Hazratbal, Srinagar - 190 006, Jammu and Kashmir
India

*Corresponding author; email: profdar99@gmail.com

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