THREATENED MEDICINAL PLANTS AND THEIR CONSERVATION IN HIMACHAL HIMALAYAS

HEMANT K. BADOLA AND MOHINDER PAL*

G.B. Pant Institute of Himalayan Environment & Development, Himachal Unit, Mohal-Kullu (Himachal Pradesh).

Introduction

The unprecedented rate of species extinction in recent times projects about quarter of the global species to be lost or threatened by the middle of 21st century (Raven, 1990). With growing global concern for species endangerment, especially over the past two decades, the term biodiversity has encouraged conservationists to look for causes and consequences of species extinction and finding ways for their conservation. Human activity and unsustainable harvesting in the wild have been identified as one of the biggest causes of reported phenomenal loss of species (Lewin, 1986; Wilson, 1988). The recent IUCN Red List sampled 91% plant species as threatened due to habitat loss and degradation (Hilton-Taylor, 2000). India is ranked at sixth for having the largest number of threatened plant species in the above IUCN Red List. It is well understood that the threatened species are most prone to extinction and by understanding the processes that contribute to their rarity, future loss of diversity may be deferred or reduced (Flather *et al.*, 1994).

With growing awareness of the people towards use of herbal medicine by mid-1980s to the 1990s, about 233 major pharmaceutical companies globally became involved in screening plants for new leads (Aryal, 1993). About 2,500 wild plant species are reported in use for medicinal purposes in Indian sub-continent, of which, possibly about 300 taxa are used in 8,000 licensed pharmaceuticals in India (Ahmad, 1993). In recent years, India has emerged as one of the biggest suppliers of raw material (Holley and Cherla, 1998), ranking second amongst 12 world leading exporter countries (Lange, 1997). Most of the raw material is procured from wild habitats, causing threat to several high value species. Limited wild stock and their further exhaustion puts a question mark to a sustainable raw material supply. Collection of medicinal herbs as Minor Forest Produce (MFP) under forest law as traditional rights in designated forest land (Anderson, 1886) has been an important source of the natives' income in Himachal Himalaya (Dobriyal *et al.*, 1997; Tandon, 1997; Badola, 1998, 2002). Ruthless extraction and illegal (unrecorded) trade, however, is well acknowledged with other factors contributing to endangerment of medicinal plants.

Understanding threat categorization of targeted taxa is critical to finding approaches for species conservation. The latest IUCN criteria define a taxon as "Endangered when it is not Critically

* G.B. Pant Institute of Himalayan Environment & Development, Kosi-Katarmal, Almora (Uttaranchal).

Endangered but is facing a very high risk of extinction in the wild in the near future". All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable, and together these categories are described as threatened (Hilton-Taylor, 2000). For quantitative evaluation, it provides a detailed assessment method with several level of taxa understanding from population data to distribution scale (Hilton-Taylor, 2000). However, assessing threatened taxa in a broader canvas is an important aspect of conservation strategy (Badola and Pal, 2002).

This paper highlights available information on the rare, sensitive, endangered and threatened medicinal plant species of Himachal Himalaya for their availability, use, nativity, endemism, and conservation prioritization. It addresses the gaps in the existing information and indicates steps for effective conservation of endangered and threatened medicinal plants in the region.

Area description

Representing the North-West part of the Indian Himalayan Region (Rodgers and Panwar, 1988), the Himachal Himalayas or the State of Himachal Pradesh is located between 30° 22' 40" and 31° 12' 40" N latitudes and 75° 47' 55" to 79° 04' 20" E longitudes. Altitude-wise, it falls between 350 m to 6,975 m from sea level. The geographical area of Himachal Himalayas, i.e. 55,673 km^2 makes 9.42 % of that of the Indian Himalayan Region. As per Forest Survey of India, the actual forest cover of the Himachal Himalayas is 22.5 %; however, a recent report provides a declined figure, i.e. 17.15 % to that of the entire State (Joshi *et al.*, 2001).

The Himachal Himalayas support sub-tropical climate at lower ranges; majority of the region falls in temperate, and alpine at high mountains, which are covered with snow during most of the year. The four agro-climatic zones, viz. Shivalik hills (rainfall 1,500 mm; upto 800 m amsl), mid-hills (rainfall 1,800 mm; 800 to 1,600 m amsl), dry hills (rainfall 1,000 to 1,500 mm; 1,600 to 2,700 m amsl) and cold dry region (rainfall < 200 mm; > 2,700 m amsl), respectively, cover 35, 32, 25 and 8 % of it's geographical area (Badola, 2001). Joshi *et al.* (2001) have described the forests of Himachal Himalayas as temperate conifer, mixed (moist and dry temperate), sub-alpine, sub-tropical (moist deciduous, swamp and pine) and broad-leaved (tropical dry deciduous and sub-tropical dry evergreen). A diversity of habitats in these forests offers niches for a variety of medicinal plants.

Approach

The information compiled in this paper considers research papers, reports, records in the State's Departments, floras and is partly from the authors' primary observations as well. It endorses the medicinal plants of Himachal Himalayas, which have been referred as rare, threatened and/or endangered in different scientific publications either through field studies, reviewing the status using matrix and/or international standard group exercises by the experts. In this paper these taxa would be cumulatively referred as Threatened Medicinal Plants (TMPs).

Medicinal Plants : A General View

A rough estimate and secondary sources suggest availability of about 1,000 to 1,200 medicinal plant species in

Himachal Himalayas (Gupta, 1964, 1971; Uniyal and Chauhan, 1971; Chowdhury and Wadhwa, 1984; Singh and Aswal, 1992; Gaur and Singh, 1993; Chauhan, 1999; Badola, 2001). As per habit type, these share 18 % trees, 21 % shrubs, 55 % herbs in composition (Badola, 2001) which coincides more or less with that of Indian Himalayan Region, having 23 %, 22 % and 58 % species as trees, shrubs and herbs, respectively (Samant *et al.*, 1998). Assessment of 360 medicinal plant species for Himachal Himalayas (Badola, 2001) offers an advantageous position, comparing earlier reports (Gupta, 1964, 1971; Singh and Aswal, 1992; Gaur and Singh, 1993; Chauhan, 1999), as the study provides a balanced ratio of woody and non-woody taxa, projecting diversified habitat environments.

Focusing Threatened Medicinal Plants

The present study assessed a total of 133 medicinal plants of Himachal Himalaya referred as rare, sensitive, threatened and/or endangered for the State and/or other parts of the Himalayas (Nayar and Sastry, 1987, 1988, 1990; Pandey *et al.*, 1993; Anon., 1997; Anon., 1997-98 to 2001-2002; Ved and Tandon, 1998; Gaur, 1999; Kala, 2000; Dhar *et al.*, 2000; Anon., 2001; Badola and Pal, 2002; Kala, 2002). Conservation prioritization (exercises) carried out in Kullu CAMP using IUCN criteria (Ved and Tandon, 1988) and in Kullu international workshop (Badola and Pal, 2002) considered 45 TMPs in total (Table 1). These are included in 133 taxa, assessed for this paper in total. In both the exercises, 7 species, viz. *Aconitum heterophyllum, Angelica glauca, Dactylorhiza hatagirea, Ephedra gerardiana, Picrorhiza kurroa, Podophyllum hexandrum* and *Nardostachys jatamansi*, were common. Assessed 133 TMPs cover 59 families (Table 2). Such family diversity of the taxa may provide better chances for conservation for having diverse habitat niches. Amongst them, 31 families harbour only one TMP species for each. These include some high-value trade taxa such as, *Acorus calamus, Cinnamomum tamala, Dioscorea deltoidea, Picrorhiza kurroa, Punica granatum,* and *Taxus baccata.* Three families, viz. Apiaceae, Asteraceae and Ranunculaceae are under the highest threats for having 10 TMPs per family, which include some of the high-value trade taxa, such as, *Angelica glauca, Centella asiatica, Heracleum candicans, Inula racemosa, Jurinea dolomiaea, Saussurea costus.* Liliaceae is the only family having 8 important TMPs including *Gloriosa superba*, the second ranked prioritised endangered taxa for *ex-situ* cultivation in low altitude zone (Badola and Pal, 2002). As per habit type, the total 133 TMP species constitute 17% trees, 23% shrubs and 60 % herbs.

Out of total TMPs mentioned in this analysis, over 53% taxa are native to the Himalayan region, however, mixes of other biogeographical elements indicate a diversity of habitat availability in Himachal Himalaya for these taxa. On analysing distribution of TMPs along vertical gradients in Himachal, the altitudes between 2,000-3,000 m are found to be most favourable habitat zone for having maximum number of species (80), including some of the high value endangered taxa such as *Angelica glauca, Swertia chirata* and *Inula racemosa.* At the same time, it is indicative of having highest threat for the medicinal plants. The altitudes between 1,000-2,000 m and

Table 1

Threatened medicinal plants of Himachal Himalaya, assessed for conservation prioritization through Kullu CAMP (using IUCN criteria; Ved and Tandon, 1998[1]) and experts' group exercise in Kullu International workshop (Badola and Pal, 2002[2])

Species	Family	Life form	Part used	Altitude (m)	Nativity	Conservation Assessment
1	2	3	4	5	6	7
Aconitum chasmanthum Stapf. ex Holms	Ranunculaceae	Herb	Root (rhizome)	3000-4200	Reg Himal	Data deficient[1]
Aconitum deinorrhizum Stapf.	Ranunculaceae	Herb	Root (tuber)	2400-4500	Reg Himal	Endangered[1]
Aconitum heterophyllum Wall. ex Royle	Ranunculaceae	Herb	Root	3000-4200	Reg Himal	Endangered[1, 2]
Aconitum violaceum J. ex Stapf	Ranunculaceae	Herb	Root	3500-4500	Reg Himal	Vulnerable[1]
Angelica glauca Edgew	Apiaceae	Herb	Root	2000-3000	Reg Himal	Endangered[1, 2]
Arnebia benthamii I. M. Johnstone	Boraginaceae	Herb	Plant, root	3000-4300	Reg Himal	Critically endangered[1]
Arnebia euchroma (Royle) John	Boraginaceae	Herb	Root	3100-4100	Reg Himal	Endangered[1]
Artemisia maritima L.	Asteraceae	Herb	Leaf, root	2500-3900	Europe Reg Caucas Sibir	Vulnerable[1]
Atropa acuminata Royle.	Solanaceae	Herb	Leaf, root	1500-3500	Europe or Ind Or	Endangered[2]
Bergenia stracheyi (Hook & Thom) Engl	Saxifragaceae	Herb	Root (rhizome)	2500-4000	Reg Himal	Vulnerable[1]
Betula utilis D. Don	Betulaceae	Tree	Bark, resin	2700-4000	Reg Himal, Japan	Endangered[1]
Cinnamomum tamala (Buch-Ham,) Nees.	Lauraceae	Tree	Leaf, bark	450-2100	Reg Himal	Endangered[2]
Dactylorhiza hatagirea (Don) Soo	Orchidaceae	Herb	Root (tubers)	2500-4000	Reg Himal	Critically endangered[1], Endangered[2]

Contd...

1	2	3	4	5	6	7
Ephedra gerardiana Wall. ex Stapf.	Ephedraceae	Shrub	Leaf, stem, fruit, root	2400-4000	Europe, Asia, Borealis	Vulnerable[1], Endangered[2]
Ferula jaeschkeana Vatke	Apiaceae	Herb	Stem (gum-resin)	2400-3600	Reg Himal, Bor Occ Turkest	Vulnerable[1]
Fritillaria roylei Hook	Liliaceae	Herb	Root (bulb)	2600-3900	Reg Himal	Endangered[1]
Gentiana kurroo Royle	Gentianaceae	Herb	Plant	1800-2800	Reg Himal	Endangered[1]
Gloriosa superba L.	Liliaceae	Herb	Root (rhizome)	250-1700	As Trop	Endangered[2]
Heracleum lanatum Michx.	Apiaceae	Herb	Plant	3000-3800	Amer, Bor Asia, Occ	Vulnerable[1]
Hippophae rhamnoides L.	Elaeagnaceae	Shrub	Fruit	2100-3600	Europe Asia Tropical	Lower risk-Near threatened[1]
Hyoscyamus niger L.	Solanaceae	Herb	Leaf, flower, seed	2200-4000	Reg Himal, Eur, Asia, Occ	Lower risk-Near threatened[1]
Jurinea dolomiaea Boiss	Asteraceae	Herb	Root	2800-4300	Reg Himal	Vulnerable[1]
Malaxis muscifera (Lindl.) Kuntze	Orchidaceae	Herb	Root (tuber)	2500-3800	Reg Himal	Vulnerable[1]
Meconopsis aculeata Royle.	Papaveraceae	Herb	Root	2900-4200	Reg Himal	Vulnerable[1]
Nardostachys jatamansi DC.	Valerianaceae	Herb	Root	3000-4300	Reg Himal	Endangered[1,2]
Physochlaina praealta (Decne.) Miers.	Solanaceae	Herb	Plant	2400-4000	Reg Himal	Vulnerable[1]
Picrorhiza kurroa Benth	Scrophulariaceae	Herb	Root	3300-4700	Reg Himal	Endagnered[1,2]
Podophyllum hexandrum Royle	Berberidaceae	Herb	Fruit, root (rhizome)	2400-4000	Reg Himal	Endangered[1,2]
Polygonatum multiflorum (L.) All	Liliaceae	Herb	Root	1500-2700	Europe As, Bor	Vulnerable[1]
Polygonatum verticillatum (L.) All	Liliaceae	Herb	Root (tubers)	1500-3500	Europe, Asia, Borealis	Vulnerable[1]

Contd...

1	2	3	4	5	6	7
Rauvolfia serpentina Benth. ex Kurz.	Apocynaceae	Shrub	Root	250-900	Ind Or Java	Endangered[2]
Rheum australe D. Don	Polygonaceae	Herb	Root (rhizome)	3000-4200	Reg Himal	Vulnerable[1]
Rheum moorcroftianum Royle	Polygonaceae	Herb	Root (rhizome)	3500-4700	Reg Himal	Vulnerable[1]
Rheum speciforme Royle	Polygonaceae	Herb	Root	3000-4800	Reg Himal	Vulnerable[1]
Rheum webbianum Royle	Polygonaceae	Herb	Root (latex)	2400-4300	Reg Himal	Vulnerable[1]
Rhododendron anthopogon D. Don	Ericaceae	Shrub	Leaf	3000-4300	Reg Himal As, Bor	Vulnerable[1]
Rhododendron campanulatum D. Don	Ericaceae	Shrub	Leaf, flower, root	2800-4000	Reg Himal	Vulnerable[1]
Rhododendron lepidotum Wall.	Ericaceae	Shrub	Leaf	2500-4000	Reg Himal	Vulnerable[1]
Saussurea costus (Falc) Lipsch.	Asteraceae	Herb	Root	2500-3600	Reg Himal	Endangered[2]
Saussurea gossypiphora D. Don	Asteraceae	Herb	Root, flower	3800-4200	Reg Himal	Endangered[1]
Saussurea obvallata (DC) Edgew	Asteraceae	Herb	Flower, root	3500-4600	Reg Himal	Vulnerable[1]
Selinum tenuifolium Wall. ex C.B. Clarke	Apiaceae	Herb	Root	2700-4000	Reg Himal	Lower risk-Least concern[1]
Selinum vaginatum (Edgew) Clarke	Apiaceae	Herb	Root (rhizome)	2500-3900	Reg Himal	Lower risk-Least concern[1]
Swertia chirata (Roxb. ex Flem.) Kars.	Gentianaceae	Herb	Plant	1500-3300	Reg Himal	Endangered[2]
Valeriana jatamansi Jones	Valerianaceae	Herb	Root-rhizome	1500-3800	Reg Himal	Locally threatened[2]

Table 2

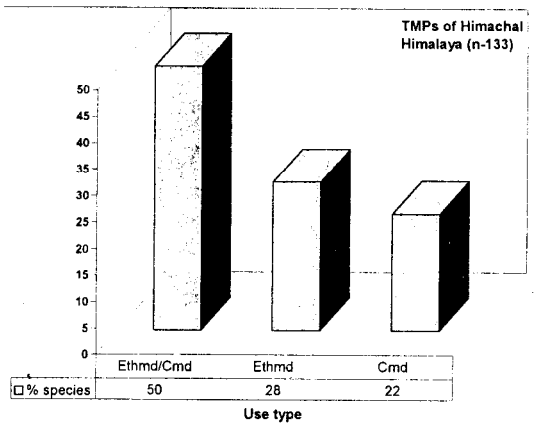
Descending order of sensitive families of Himachal Himalaya for having maximum to minimum number of threatened taxa

No. of spp. per family	No. of families	Important families	Important threatened/sensitive species
10	3	Apiaceae, Asteraceae, Ranunculaceae	*Angelica glauca, Centella asiatica, Ferula jaeschkeana, Heracleum candicans, Heracleum lanatum, Inula racemosa, Jurinea dolomiaea, Saussurea costus, S. obvallata, S. gossypiphora.*
8	1	Liliaceae	*Colchicum luteum, Fritillaria roylei, Gloriosa superba, Polygonatum cirrhifolium, P. verticillatum.*
5	2	Solanaceae, Berberidaceae	*Atropa acuminata, Berberis aristata, B. asiatica, B. lycium, Hyoscyamus niger, Physiochlaina praealta, Podophyllum hexandrum.*
4	2	Orchidaceae, Polygonaceae	*Dactylorhiza hatagirea, Malaxis muscifera, Rheum australe, R. moorcroftianum, R. webbianum.*
3	7	Asparagaceae, Betulaceae, Ericaceae, Fabaceae, Gentianaceae Valerianaceae, Zingiberaceae	*Abrus precatorius, Asparagus racemosus, Betula utilis, Gentiana kurroa, Hedychium spicatum, Nardostachys grandiflora, Rhododendron anthopogon, R. campanulatum, R. lepidotum, Swertia angustifolia, S. chirayita, Valeriana jatamansi.*
2	13	Anacardiaceae, Apocynaceae, Boraginaceae, Caesalpiniaceae, Lamiaceae, Mimosaceae, Menispermaceae, Moringaceae, Pinaceae, Papaveraceae, Rutaceae, Saxifragaceae, Verbenaceae	*Arnebia benthamii, A. euchroma, Bergenia stacheyi, Cassia tora, Cedrus deodara, Holorrhena antidysentrica, Meconopsis aculeata, Mimosa pudica, Rauvolfia serpentina, Thymus serpyllum, Tinosperma cordifolia.*
1	31	Araceae, Campanulaceae, Celastraceae, Cupressaceae, Dioscoreaceae, Elaeagnaceae, Ephedraceae, Fumariaceae, Lauraceae, Lythraceae, Paeoniaceae, Punicaceae, Rubiaceae, Scrophulariaceae, Taxaceae	*Acorus calamus, Celastrus paniculatus, Cinnamomum tamala, Codonopsis affinis, Corydalis govaniana, Dioscorea deltoidea, Ephedra gerardiana, Hippophae rhamnoides, Juniperus communis, Paeonia emodi, Picrorhiza kurroa, Punica granatum, Rubia cordifolia, Taxus baccata, Ulmus wallichiana, Woodfordia fruticosa.*

3,000-4,000 m also support a fair number of TMP taxa, i.e. 55 % and 52 %, respectively. One of the highest ranked endangered taxa prioritised for conservation in Himachal Himalaya, *Picrorhiza kurroa* (Badola and Pal, 2002) is found in these and above altitudes. The altitudes above 4,000 m though having lowest number (17 %) of TMPs but support several very important threatened taxa, viz. *Aconitum heterophyllum, A. violaceum, Jurinea dolomiaea, Meconopsis aculeata, Nardostachys jatamansi, Rhododendron campanulatum, Saussurea bracteata* and *S. gossypiphora*. Due to highly fragile environment of the alpine zone, these species deserve special attention for conservation. The total number of TMPs includes 34 % endemism (Indian Himalayan Region) of the total defined taxa, including 5 endemic and 40 near endemic. *Aconitum ferox, Angelica glauca, Codonopsis affinis, Inula racemosa* and *Saussurea bracteata* are the endemic taxa of high conservation concern because of their high altitude habitat requirements. Some of the top near endemic trade taxa of this study are, *Aconitum heterophyllum, Cinnamomum tamala, Dactylorhiza hatagirea, Heracleum candicans, Jurinea dolomiaea* and *Swertia chirata*.

In addition to about 22 % TMPs of Himachal Himalaya used exclusively for commerce, over 50 % species are used both ethno-medicinally and commercially (Fig. 1; cumulatively, 72 % species for commercial use), indicating unsustainable harvesting in the wild as major reason to their depletion, whereas, about 28 % TMPs exclusively under ethno-medicinal use suggest their depletion either through excessive use and/or owing to their natural low population size, and other biological reasons responsible for slow regeneration (Meffe and Carroll, 1994). Together, a high percentage (78 %) of enthno-medicinally used taxa offers clues for further research in authenticating them as a source of pharmaceutical drugs, thus helping in reducing search cost. Most of the TMPs are harvested for their one or more parts or sometimes the entire plant is used for the purpose of medicine. Fig. 2 provides species grouping for their respective use part. It reflects a higher level of destructive nature of harvesting of TMPs, i.e. through root (60 %), whole plant (16 %), and bark/wood/resin (19 %). This type of harvesting enhances susceptibility of taxa to endangerment, particularly if it prefers only limited and specific habitats, as in the case of *Nardostachys jatamansi* (Airi *et al.*, 2000) and other TMPs in the Himalayas (Uniyal *et al.*, 2002).

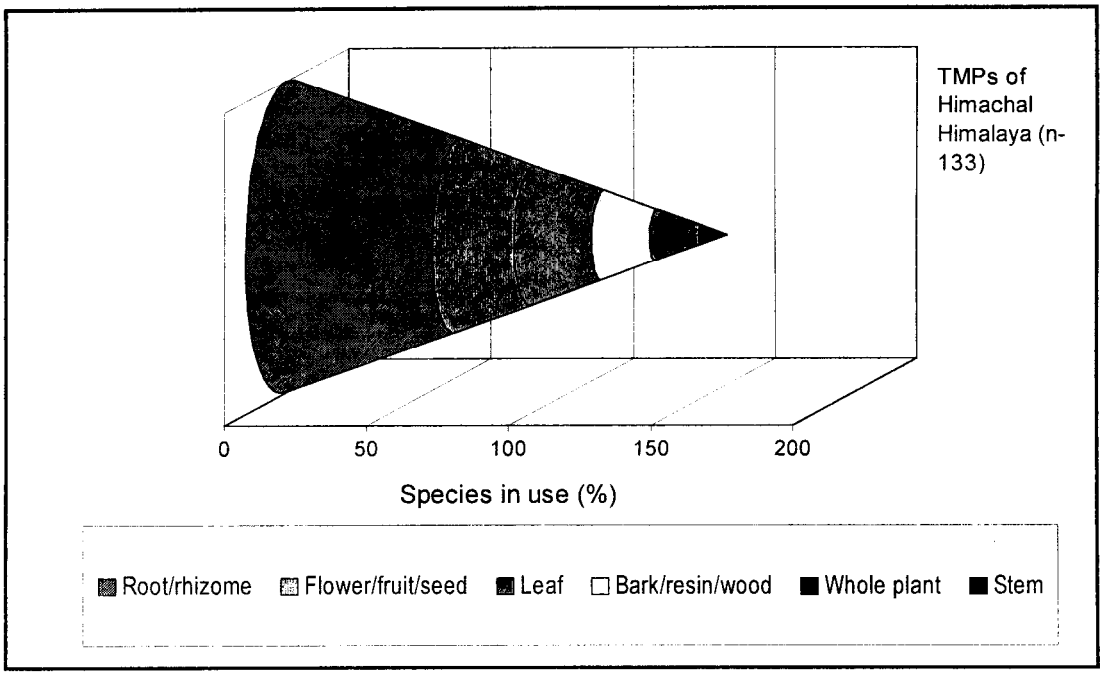
Fig. 1



Use pattern of threatened medicinal plant species of Himachal Himalaya (n-133)

Cmd-commercially medicinal; *Ethmd*-ethno-medicinal; *Ethmd/Cmd*- both as ethno-medicinal and commercially medicinal.

Fig. 1



Pattern of destructive harvesting, as per use part of threatened medicinal plant species of Himachal Himalayas (n-133)

Prioritizing Species for Conservation

Several level exercises may be helpful in the assessment of species endangerment, such as : field based population studies including species distribution pattern, harvesting pressure, trade data, and peoples' perceptions. Incorporation of historical perspectives and scattered available information for each targeted taxa would strengthen the assessment exercise. In recent times more conservationists, scientists and managers have come forward to assess and rank species according to the urgency of conservation efforts (Flather *et al.*, 1994; Dhar *et al.*, 2000; Badola and Pal, 2002). There are several papers indicating a number of species for priority attention for conservation (Khoshoo, 1993). Interesting and valuable studies (Dhar *et al.*, 2000) and assessment group exercises (Ved and Tandon, 1998; Badola and Pal, 2002) have indicated the need for more attempts to prioritize medicinal plant species covering different Himalayan regions in a much more focussed manner. Amongst the assessed 133 TMPs for this paper, *Aconitum heterophyllum* and *A. deinorrhizum*, *Codonopsis affinis*, *Dioscorea deltoidea*, *Inula racemosa*, *Nardostachys jatamansi*, *Picrorhiza kurroa* and *Saussurea costus* are listed in the Red Data Book of Indian Plants (Nayar and Sastry, 1987,1988,1990). Based on population studies in Spiti area of Himachal, Kala (2000) suggested further assessment of

some referred threatened taxa such as *Arnebia eucroma, Betula utilis, Gentiana kurroo, Picrorhiza kurroa* and *Dactylorhiza hatagirea* in more locations of the State.

Table 3 provides 14 endangered medicinal plants of Himachal Himalaya, assessed and prioritized for conservation through *ex-situ* cultivation for 4 agro-climatic zones (Badola and Pal, 2002). In prioritization, four basic criteria were considered, viz. endangered status (based on literature and local-perception), knowledge base (on population studies, multiplication technology and cultivation trials), cultivation prospects (technical and economic feasibility) and marketability (national and international). Amongst them, *Nardostachys jatamansi* (listed in Red Data Book of Indian Plants, and included in Appendix II of CITES) (Anon., 2001) and *Swertia chirata* (sensitive taxa, Dhar *et al.*, 2000) were ranked number one for their respective agro-climatic zones under conservation priority. *Dactylorhiza hatagirea*, a critically endangered taxa for Himachal Himalaya (Ved and Tandon, 1998), was prioritized for cold-desert zone, ranking second. *Picrorhiza kurroa*, another top endangered taxa (also listed in CITES Appendix II) (Anon., 2001) was taken for immediate action (*ex-situ* cultivation). These prioritization exercises need more supporting data, covering different geographical locations in the Himalayas for establishing improved and effective conservation planning in the Himalayas and particularly in Himachal Pradesh.

Table 3

Conservation prioritisation of endangered medicinal plant species for ex-situ cultivation in Himachal Himalaya (based on a workshop exercise) (Badola and Pal, 2002)

Species ranking	Cold-desert zone	High-altitude zone	Mid-altitude zone	Low-altitude zone
I	*Nardostachys jatamansi* D.C.	*Swertia chirata* (Roxb. ex. Flem.) Karstem	*Valeriana jatamansi* Jones	*Rauvolfia serpentina* Benth.
II	*Dactylorhiza hatagirea* (D.Don.) Soo	*Picrorhiza kurrooa* Royle ex Benth.	*Atropa acuminata* Royle	*Gloriosa superba* Linn.
III	*Saussurea costus* (Falc.) Lipsch.	*Aconitum heterophyllum* Wall. ex Royle	-	*Cinnamomum tamala* (Buch.-Ham) Nees & Eberm.
IV	*Ephedra gerardiana* Wall. ex Stapf.	*Podophyllum hexandrum* Royle	-	-
V	-	*Angelica glauca* Edgew.	-	-

Conservation solutions

The State Forest Deptt. in H.P.governs the norms for the trade, transport and export of medicinal plants. The export permit rule of 1993 enlists 42 medicinal plant species for which, department issues the licence to plant collectors and exporters. Of these, *Aconitum heterophyllum, Acorus calamus, Berberis* sp., *Dactylorhiza hatagirea, Dioscorea deltoidea, Picrorhiza kurroa, Podophyllum hexandrum, Saussurea costus* and *Taxus baccata* are under negative list of export in India. In recent years *ex-situ* cultivation has been realised as one of the possible solutions to TMP conservation. It is hard to accept that, only a few TMPs have been successfully established for cultivation, such as *Saussurea costus* and *Inula racemosa* are adopted as domesticated crop in the Lahaul area of Himachal Himalayas (Badola and Pokhriyal, 2001). To establish TMP cultivation, it has been stressed that trials need to be carried out at different agro-climatic zones (Badola, 2002). In recent years, scientific institutions have come forward to develop TMP cultivation programme at several levels. Recently, GBPIHED has successfully established *ex-situ* cultivation trials of some high altitude TMPs at village level in Himachal Himalaya with financial support of Department of Biotechnology, New Delhi. Habitat management, at the same time, has been given due importance to implement species conservation (Badola, 1998; Ved and Tandon, 1998). The recent Biodiversity bill, National Policy and Macrolevel Action Strategy on Bio-diversity (1999) and National Agriculture Policy (1999), setting up of Bioresource Board and Medicinal Plant Board of the Government of India has been an encouragement to conservation of TMPs.

Now experts have realized exigency of international cooperation to develop and carry forward the programmes for the TMP conservation to ensure their adequate availability possible to future generations. Recently held international workshop in Kullu (Badola and Pal, 2002) provides important steps for TMP conservation through cultivation. These include review of knowledge on targeted species, identification of best cultivation practices, R&D to reduce long-gestation periods, cost-effective technology, organic farming, buy-back assurances, policy revision in the interest of stakeholders, post-cultivation protocols, quality control and awareness building.

Succinctly, the following are some major conservation solutions for TMPs :

- Protecting ecosystems, natural habitats, and maintenance of viable populations of TMPs.
- Establishment of buffer zones in order to rehabilitate and reinstate fragmented habitats and promote recovery of TMPs using scientific planning.
- The populated agro-climatic zones adjacent to forest vicinities should be targeted on priority for *ex-situ* cultivation of TMPs. This is expected to alleviate pressure on wild habitats providing alternative source of income to natives.
- Village level co-operatives will better empower community people over marketing channel.
- Adequate training and awareness at grass-root level is crucial for long term conservation planning.
- Better co-ordination between scientific and natural area management organisations for sensible and effective TMP conservation.

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SUMMARY

The paper analyses 133 rare, sensitive and threatened medicinal plant species of Himachal Himalayas for their status with the help of use pattern, nativity and endemism and explores possibilities for their conservation. These species constitute 17% trees, 23 % shrubs and 60 % herbs distributed over 59 families. The listed species include those that have been considered prone to endangerment or referred as endangered in literature and through experts' group exercises. These include 34 % endemism (Indian Himalayan Region) of the total defined taxa in the paper. The above total assessed taxa show high nativity (>53 %) to Himalayan region. A higher percentage of species (> 50 %) under ethno-medicinal as well as commercially medicinal use category indicate high pressure on the same. Destructive nature of use pattern, i.e. root (60 %), whole plant (16 %), bark/wood/resin (19 %) further indicates threats from harvesting. Special stress is made on 45 threatened species assessed under IUCN and other experts' criteria for Himachal Himalaya. Species prioritization using different exercises is given high value in wide scale conservation strategies, either by means of *in-situ* or *ex-situ* methods.

हिमाचल प्रदेश में विलुप्ति खतरे में आए पादप तथा उनका संरक्षण

हेमन्त के० बडोला व मोहिन्दर पाल

सारांश

इस अभिपत्र मे हिमाचल के हिमालयी भाग में मिलने वाले 133 दुर्लभ, इस प्रभविष्णु और विलुप्ति खतरे में आए औषध पादपों की वर्तमान स्थिति का उनके उपयेाग की रूपसज्जा, देशीयता और स्थानसीमिता की सहायता से विश्लेषण किया गया है और उनके संरक्षण की संभावनाएं खोज-पड़ताली गई हैं । इन जातियों में 17% वृक्ष, 23% क्षुप और 60% शाक है जो 59 से अधिक कुलों में वितरित हैं । सुची में ली गई जातियों में इनहें रखा गया है जिनकी विलुप्ति खतरे में आने की आशंका है अथवा जिन्हें वाङ्मय और विशेषज्ञ दलों के अभ्यासों में खतरे में आई कहा गया है । इनमें स्थानसीमित जातियां (भारतीय हिमालय प्रदेश) अभिपत्र में परिभाषित कुल जातियों का 34% हैं । ऊपर आकलित जातियों में अधिक देशीयता (>53%) हिमालयी प्रदेश के प्रति दिखाई पड़ती है । जातियों का और भी बड़ा प्रतिशत (>50%) जाति औषधियों तथा व्यापारिक चिकित्सीय उपयोग श्रेणी के अन्तर्गत है जो उनपर भारी दबाव पड़ने का सूचक है । उपयोग सज्जा की विनाशक प्रकृति अर्थात् जड़ें (60%), पूरा पौधा (16%), छाल/काष्ठ/लीसा (19%) उनकी कटाई से आने वाले खतरे की सूचक है । आई यू सी एन और अन्य विशेषज्ञों द्वारा हिमाचल के हिमालयी प्रदेश के लिए बनाई गई कसौटियों के अधीन आकलित 45 संकटापन्न जातियों पर विशेष बल दिया गया है । विस्तृत संरक्षण समरनीतियों में विभिन्न अभ्यासों को उपयोग में लाते हुए, मूल प्रदेश में अथावा मूल प्रदेश से बाहर संरक्षण करने की विधि अपनाकर प्राथमिकता-निर्धारण करने को अधिक मान्यता दी गई है ।

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