

## DIVERSITY, DISTRIBUTION, AND CONSERVATION STATUS OF ORCHIDS ALONG AN ALTITUDINAL GRADIENT IN HIMACHAL PRADESH, NORTH WESTERN HIMALAYA

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### Abstract

Orchids comprise one of the largest families of flowering plants and cover 6.8% of the flowering plants in India. They are prized for their incredible diversity in size, shape, forms, colour, attractiveness of their flowers and high keeping qualities upto ten wks. While exploring the floristic diversity of the biodiversity rich areas of the Himachal Pradesh, an attempt was made to assess the diversity, distribution and conservation status of orchids along an altitudinal gradient in Hirb and Shoja Catchments in Kullu district, Chailchowk-Rohanda-Kamrunag area and Mandi-Pandoh area in Mandi district and Ghanahatti-Shimla area in Shimla district. Extensive and intensive field surveys revealed the occurrence of 29 species of orchids, mostly terrestrial belonging to 16 genera. Amongst genera, *Habenaria* (8 spp.), *Goodyera* (3 spp.), *Calanthe*, *Epipactis*, *Herminium*, *Listera* and *Malaxis* (2 spp., each) were dominant. Majority of species (25) were distributed between 1800-2800 m altitudes, whereas at elevations higher and lower than these, relatively less diversity of orchids was recorded. Amongst the different sites, Chailchowk-Rohanda-Kamrunag area (19 spp.) represented maximum species of orchids, followed by Hirb and Shoja Catchments (12 spp.), Ghanahatti-Shimla area (7 spp.) and Mandi-Pandoh area (5 spp.). Fifteen species were native to the Himalayan region and 7 species were near endemic to the Indian Himalayan Region. One species (*Dactylorhiza hatagirea*) was identified as critically endangered and 6 species as endangered and 11 as vulnerable. The over exploitation of orchids for trade, habitat loss and climate change are major factors leading to rapid decrease in their population. These factors have led to habitat destruction, changes and fragmentation. Therefore, assessment of the habitats and populations of the orchids is essentially required to understand the dynamics of the habitats and status of the species which would help in developing appropriate strategy for *in situ* conservation of the orchids, in Himachal Pradesh.

### Introduction

THE INDIAN Himalayan Region (IHR) is rich in biodiversity and supports about 8,000 flowering plants, and is amongst the identified biodiversity Hot spots. Orchids are fascinating group of flowering plants which show a broad range of habitats and prefer specific microclimatic conditions for their growth and development; these plants constitute one of the highly evolved, diverse and successful families (Orchidaceae) of flowering plants. Orchidaceae is amongst the largest families of flowering plants covering 6.8% of the flowering plants in India (Samant, 2002; Singh and Hajra, 1996). They are prized for their incredible diversity in size, shape, forms, colour, attractiveness of their flowers and high keeping qualities up to ten wks. The family is very well represented particularly in the Central (Sikkim and Darjeeling Hills) and Eastern Himalaya. About 64.14% of the total orchids reported from India are represented in the IHR. In Himachal Pradesh, there is a low percentage, but the representation of orchid species is unique. This unique diversity of orchids is under severe threats due to various anthropogenic activities and natural processes. Orchids are worldwide

famous for their charming and long lasting flowers. In India, 9% of flora (1300 species and 140 genera) composed of orchids which are present predominantly in temperate Himalaya. They form a diverse group of plants and represent a peak in the evolution of monocots. They are cultivated for beautiful flowers and widely known for their economic importance but less for their medicinal value. They are terrestrial, epiphytic and saprophytic in nature. The diversity of orchids decreases from North East to North West Himalaya (Chowdhery, 1999; Chowdhery and Wadhwa, 1984; Deva and Naithani, 1986; Pangtey *et al.*, 1991; Samant 2002, 2009). The North Indian hill state, Himachal Pradesh, is also very well known for its typical topography, large altitudinal range, diverse habitats and representative, natural, unique and socio-economically important biodiversity. It supports 29 Wildlife Sanctuaries, 05 National Parks, 03 Conservation Reserves and 01 Biosphere Reserve. Most of the protected areas are unexplored and under explored especially for orchid diversity. On the other hand, medicinal properties and traditional uses of orchids are less studied in this state till now. Further, scanty population of these plants due to their complex nutrition

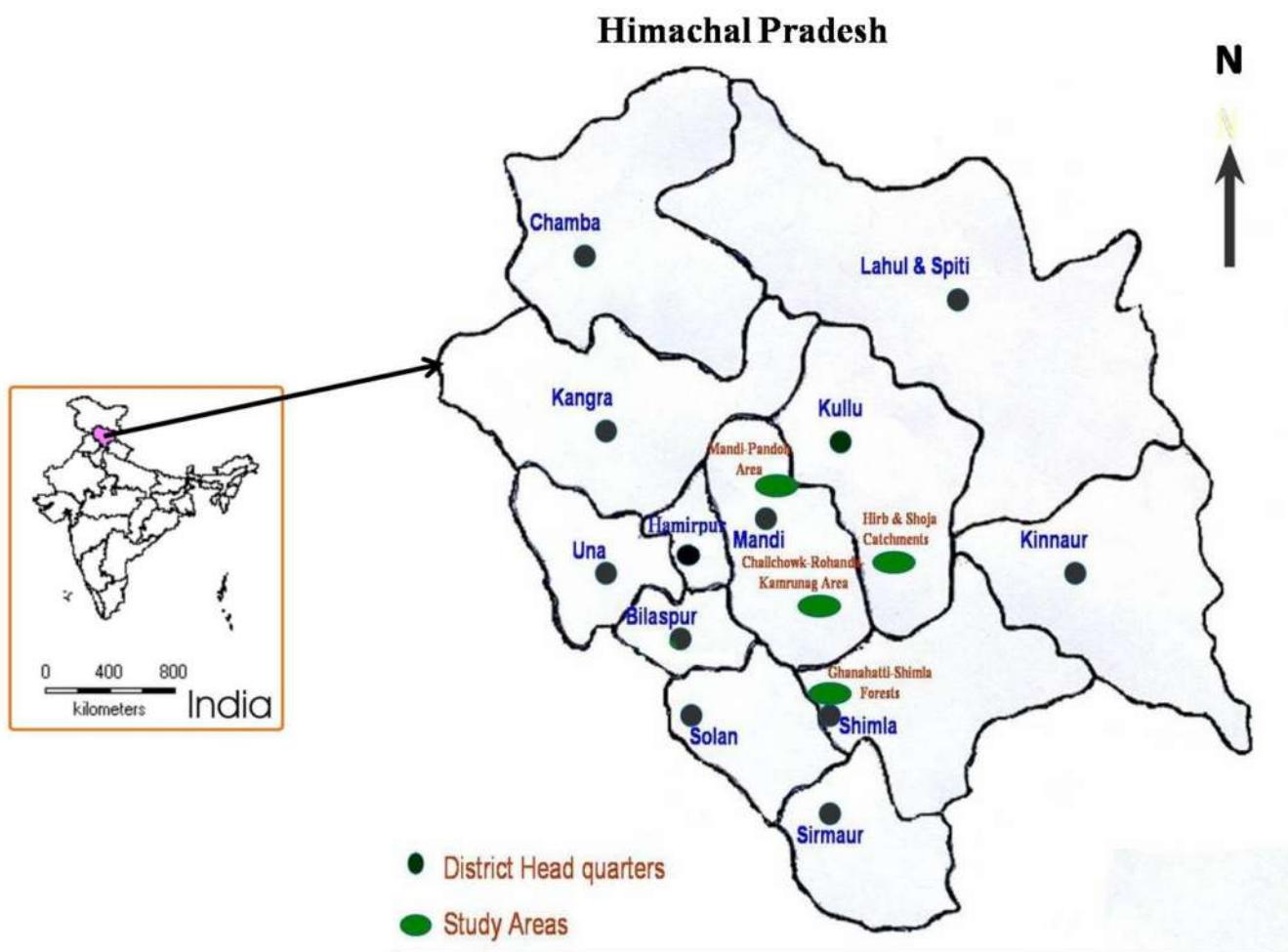


Fig. 1. Map of the study areas at an altitudinal gradient in Himachal Pradesh.

requirement and anthropogenic activities makes them highly vulnerable.

In general, a large number of studies have been carried out in the IHR (Arora, 1986; Balodi, 1987; Deva and Naithani, 1986; Duthie, 1906; Samant, 2009; Samant *et al.*, 1995; Verma *et al.*, 2013; Vij *et al.*, 1983). In Himachal Pradesh, a very few studies are available on orchids (Lal *et al.*, 2004; Marpa and Samant, 2012; Pathak *et al.*, 2010, 2011a; Rana *et al.*, 2008, Verma *et al.*, 2015). In general, mention of orchids has also been made in the floristic studies (Dhaliwal and Sharma, 1999; Singh and Rawat, 2000) but not much work has been done in the state on the region specific threat status of orchids in particular. Therefore, the present attempt has been made to; i) assess and identify the diversity of orchids; ii) assess the status of native and endemic orchid species; iii) assess the medicinally important orchid diversity; iv) identify the threatened orchid diversity in Himachal Pradesh region; and v) suggest management options for the conservation.

## Materials and Methods

### Study Area

Four sites namely Hirb and Shoja Catchments, Chailchowk-Ruhanda-Kamrunag, Mandi-Pandoh, and Shimla-Ghanahatti areas were selected along an altitudinal gradient (Fig. 1). Hirb and Shoja Catchments ( $31^{\circ}32.078'$  to  $31^{\circ}34.394'$  N Latitudes and  $77^{\circ}09.092'$  to  $77^{\circ}25.448'$  E Longitudes) of the Saraj Forest Division are locations at Kullu District in Himachal Pradesh. These catchments cover  $40.66\text{ km}^2$  area with an altitudinal range 2000-3650 m amsl, and are very well known for their diverse habitats, microclimatic conditions, and rich biodiversity including flora and fauna. These are mainly dominated by temperate and sub-alpine broad leaved and coniferous forests, alpine scrubs and alpine herbaceous vegetation, and support a large number of sensitive biodiversity elements including medicinal, wild edibles, rare endangered, native, endemic and wild relatives of crop plants.

Climatically, the area is unique; the temperature ranges between -4°C to 30°C. The catchments are mainly inhabited by Pachhijhaun, Ghoindhar, Marotan, Sajwar, Jalora, Nali, Shoja, Bohalidhar, and Ghayagi villages.

Chailchowk-Ruhanda-Kamrunag Area is located in the Mandi district covering an altitudinal range 1,300-3,050 m amsl. The Beas and Satluj are the two main rivers of this district and the geological configuration consists of four prominent ridges i.e., Nargu-unga Dhar, Ghoghar Dhar, Shikandar Dhar and Dhar Varikot. The vegetation mainly comprises of sub-tropical, temperate and sub-alpine types. The temperate and sub-alpine forests are mainly dominated by broad leaved deciduous and evergreen coniferous species. Climatically, the area is unique, the temperature ranges between -4°C to 38°C and mean annual rainfall is 1568 mm.

Shimla-Ghanahatti Area is located in the North-Western ranges of the Himalaya between 31° 05.422' to 31° 09.238' N latitudes and 77° 04.359' to 77° 11.068' E longitudes and altitudinal range 1500-2400 m. The main forest type of the area is moist temperate forest which covers an area of 5,131 km<sup>2</sup>. The climate is predominantly cold during winter and pleasantly warm during summer. The temperature ranges from 3.95 °C to 32.95 °C over the year. The average temperature during summer is between 14 °C and 20 °C and between -7 °C and 10 °C in winter. Rainfall in the region varies between 24.0 mm to 1020.0 mm. The average rainfall is 900 mm and the average snowfall is around 115 cm.

Mandi-Pandoh Area (31° 43.01' N to 31° 42.455' N latitudes and 76° 59.312' E to 77° 00.027' E longitudes, and altitudinal range 700-1000 m) is located in Mandi district. The vegetation mainly comprises of sub-tropical type, and dominated by broad leaved deciduous trees. Climatically, the area is unique, the temperature ranges between 2°C to 38°C and mean annual rainfall is 1442 mm. The inhabitants residing in the periphery and in the middle of the area are dependent largely on the forest area for minor forest products (including medicinal and wild edible plants), fuel, fodder, timber, livestock grazing, and various other purposes.

#### Surveys, Sampling, Identification and Data Analysis

The extensive and intensive field surveys were conducted to study the orchid diversity along an altitudinal gradient in the selected sites during 2007-2011. The rapid sampling of the species was done and the samples of each species were collected for proper identification. For each species, information on habit, habitat, altitudinal range, population size, indigenous uses, etc. was collected. The species were identified with the help of floras and literature (Deva and Naithani,

1986; Dhaliwal and Sharma, 1999; Duthie, 1906; Samant, 1993; Singh and Rawat, 2000). Species were analyzed for nativity, endemism, and rarity. Nativity of the species was identified following Anonymous (1883-1970), Samant (2002), and Samant et al. (1998). Endemism of the species was identified based on distribution range following Dhar and Samant (1993) and Samant et al. (1998). Species confined to the IHR were considered as endemic, and those with a distribution extending to neighboring countries (Himalayan region of Afghanistan, Pakistan, Tibet, Nepal, Bhutan and adjacent states of the IHR) were considered as near endemic. For assessing the threat categories of the orchid species, habitat preference, population size, distribution range and use value(s) were collectively used following, Rana and Samant (2010), and Samant et al. (1996). Information on the indigenous uses of the species is based on the available literature and interviews of the inhabitants in selected sites.

## Results

### Diversity and Distribution Pattern

In total, 29 species of the orchids representing 16 genera which were mostly terrestrial were presently recorded. These orchid species were found in diverse habitats i.e., shady moist forests, alpine meadows, moist alpine slopes and boulders, etc. Of these, 5 species of orchids were recorded from <800 m, 17 species in 800-1800 m, 18 species in 1800-2800 m, and 14 species in 2801-3800 m altitudinal zones (Fig.2). Amongst the species, 5 species were recorded from three areas while 6 from two areas and rest have their representation to a single area. Fifteen species (*Calanthe plantaginea*, *C. tricarinata*, *Dactylorhiza hatagirea*, *Epipactis heleborine*, *Goodyera biflora*, *G. fusca*, *Habenaria edgeworthii*, *H. intermedia*, *H. pectinata*, *Listera pinetorum*, *L. tenuis*, *Malaxis acuminata*, *M. muscifera*, *Nervillia prainiana* and *Vanda cristata*) were native to the Himalaya and 14 non-natives (*Cephalanthera longifolia*, *Epipactis giganteum*,

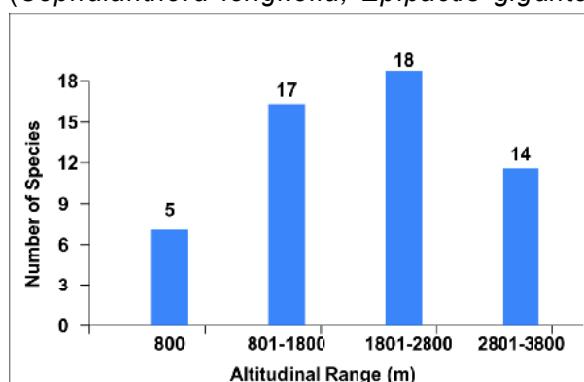


Fig. 2. Altitudinal distribution of orchids in Himachal Pradesh.

*Eulophia dabia*, *Goodyera repens*, *Habenaria constricta*, *H. goodyeroides*, *H. latilabris*, *H. marginata*, *Herminium lanceum*, *H. monorchis*, *Ophrys lancea*, *Rhynchostylis retusa*, *Satyrium nepalense*, *Spiranthes spiralis*). Six species (*Calanthe plantaginea*, *Dactylorrhiza hatagirea*, *Goodyera biflora*, *Habenaria intermedia*, *Habenaria pectinata* and *Satyrium nepalense*) were near endemic and one species, *Habenaria edgeworthii* was endemic to the IHR (Table 1). Considering the whole Himalayan region, the near endemic species also become endemic. Among genera, *Habenaria* (7 spp.), *Goodyera* (3 spp.), *Herminium*, *Epipactis*, *Malaxis*, and *Listera* (2 spp., each) were dominant.

#### Indigenous Uses and Traditional Practices

Different plant parts namely, leaves (10 spp.), tubers (08 spp.), aerial parts (05 spp.), bulbs (4 spp.), rhizomes and roots (3 spp. each) were used by the inhabitants for various therapeutic uses (Fig. 3). Tubers of *Habenaria edgeworthii* (known as *Riddhi* in Ayurveda) were considered to be blood purifier and energy booster, and *Habenaria pectinata*, these were used for curing joint pains by the local folks. Tubers and leaves of *Habenaria intermedia* (known as *Vridhi* in Ayurveda) were used for curing blood diseases, and *Goodyera biflora* and *G. repens*, these were considered as very good appetizers. *Malaxis acuminata* (known as *Jeevak* in Ayurveda) is a key Ashtavarga plant and used for curing arthritis, blood purification and as an aphrodisiac and *Malaxis muscifera* is also used as a potential aphrodisiac. Likewise, other species were used for curing various ailments such as sores, eczema, paralysis, wounds, bone fracture, cough, cold, cuts, sexual disability, rheumatism, fever, blood purification, cold, dysentery, sterility, leucorrhea, diabetes, malaria etc., and also used as aphrodisiac, antispasmodic, sedative, febrifuge, appetizer and tonic (Table 1 and Fig. 4). Due to extensive over use and unscientific extraction, the density of these plants is decreasing at an alarming rate. The populations of *Dactylorrhiza hatagirea*, *Malaxis acuminata* and *Malaxis muscifera* were decreasing fast due to habitat degradation and their commercial exploitation.

#### Threat Status

Present investigation regarding the status of the orchid species at altitudinal gradient in Himachal Pradesh revealed that one species namely, *Dactylorrhiza hatagirea* was Critically Endangered; 6 species (*Epipactis heleborine*, *Goodyera biflora*, *Habenaria edgeworthii*, *Habenaria intermedia*, *Herminium monorchis* and *Malaxis muscifera*) were Endangered; 11 species (*Calanthe plantaginea*, *Cephalanthera longifolia*, *Epipactis giganteum*, *E. latifolia*, *Goodyera*

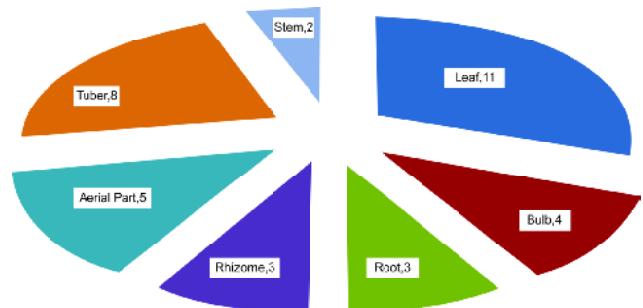


Fig. 3. Parts of economically important orchids used in Himachal Pradesh.

*repens*, *Habenaria pectinata*, *Listera pinetorum*, *L. tenuis*, *Malaxis muscifera*, *Nervillia prainiana*, and *Rhynchostylis retusa*) Vulnerable; and 3 species (*Malaxis acuminata*, *Spiranthes sinensis*, and *Satyrium nepalense*) were Near Threatened.

#### Discussion

In comparison to West, Central and Eastern Himalaya, the state of Himachal Pradesh supports relatively very less number of orchids (Deva and Naithani, 1986; Samant, 2002, 2009). However, the present study revealed that the reported orchid species are representative, natural, unique and socio-economically important. Except *Rhynchostylis retusa* and *Vanda cristata*, all the other species are terrestrial and mostly prefer shady moist habitat. The terrestrial nature of the orchid species revealed that the area received relatively less rainfall leading to low humidity which is essentially required for the growth and development of orchids. For sustaining the high existence of orchids in sub-tropical and temperate regions requires priority attention for conservation in view of the high anthropogenic pressures. The orchids inherently are slow growers and due to their complex nutritional requirements, they germinate poorly in nature which further adds to their poor population, making them more vulnerable. Orchids are highly habitat specific plants and therefore, suffer very much due to destruction of their delicately balanced

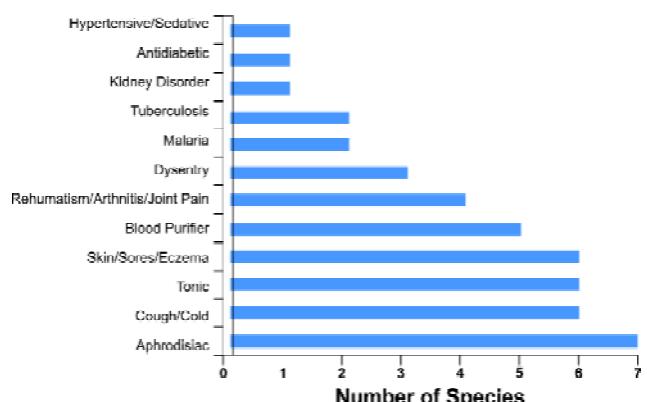
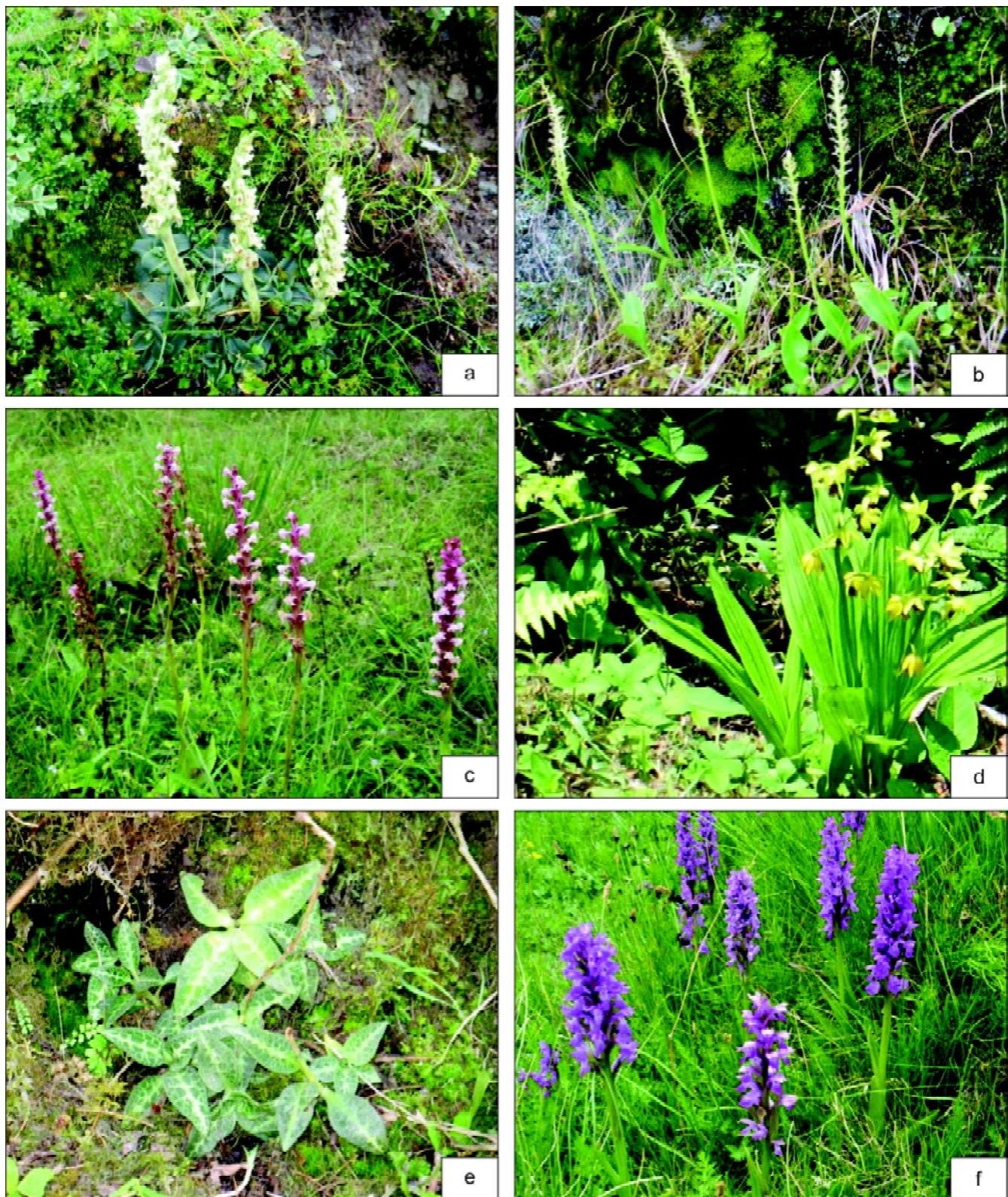


Fig. 4. Medicinal uses of orchids in Himachal Pradesh.



**Fig. 5. a-f. Different medicinal orchids in Himachal Pradesh: a, *Goodyera fusca*; b, *Malaxis muscifera*; c, *Satyrium nepalense*; d, *Calanthe tricarinata*; e, *Goodyera repens*; and f, *Dactylorhiza hatagirea*.**

habitats. Assigning threat status based on quantitative assessment was considered as one of the basic tasks

of conservation strategies (Burgman et al., 2007; Ture and Bocuk, 2010). In the present context, assigning

Table 1. Diversity, distribution, indigenous uses and conservation of orchids in Himachal Pradesh.

Taxa	Study Sites	Habitat(s)	Affitudinal range (m)	Nativity	Status	Part(s) used	Indigenous uses
<i>Calanthe plantaginea</i> Lindl.*	II	1, 2	1500-3200	Reg Himal	E	Leaf, Bulb	-
<i>C. tricarinata</i> Lindl.	I, II, III	1, 2, 3, 4, 5, 6	1500-3300	Reg Himal	CR	Leaf, Bulb	As an aphrodisiac and for curing sores, and eczema
<i>Cephalanthera longifolia</i> (L.) Fritsch.	I, II, III	1, 3	1600-1800	Europe Afr Bor As Temp	V	Root, Rhizome, Bulb	As an aphrodisiac and tonic and for curing cough, paralysis
<i>Dactylochila hatagirea</i> (D. Don) Rolfe	I, II	2, 4, 5, 9, 10	2900-3500	Reg Himal Europe Afr Bor Or	CR	Tuber	As an antibiotic, blood purifier, tonic and expectorant, wound healing, bone fracture, and for curing cough, cold, cuts, sexual disability, rheumatism
<i>Epipactis giganteum</i> Dougl. ex J.D. Hook.	I, II	1, 2	2200-3050	Am Bor As Temp	V	Leaf, Rhizome	As mood-alleviating, antispasmodic and sedative
<i>E. helleborine</i> (L.) Crantz	I, II	1, 2, 3, 9	1600-3650	Reg Himal	NT	Leaf, Rhizome	As an aphrodisiac, blood purifier and for curing fever
<i>Eulophia dabia</i> (D. Don) Hochr.	IV	1, 2	700-1000	Ind Or	-	-	-
<i>Goodyera biflora</i> (Lindl.) J.D.Hook.	II	1	1810-2600	Reg Himal	V	Aerial Part	As an appetizer, and blood purifier and for curing cold
<i>G. fusca</i> (Lindl.) J.D.Hook.	I	7, 9, 10	3100-3650	Reg Himal	E	Aerial Part	-
<i>G. repens</i> (L.) R. Br.	I, II, III	1, 2, 7, 9	2810-3300	Reg Bor Temp	V	Aerial Part	As an appetizer, and for curing cold, kidney disorder, female disorder, syphilis and blood purifier
<i>Habenaria constricta</i> (Lindl.) Hook. f.	IV	1, 2, 5	700-1000	Ind Or	-	-	-
<i>H. edgeworthii</i> * * J.D. Hook.	I, II, III	1, 2, 3, 7, 9	1940-3300	Reg Himal	E	Tuber	As blood purifier and rejuvenator
<i>H. goodyeroides</i> D. Don	IV	1, 2	700-1000	Ind Or Malaya	-	-	-
<i>H. intermedia</i> D. Don*	II	1, 2, 7	1600-2000	Reg Himal	E	Leaf, Tuber	As cooling agent, for curing spermiotic and blood diseases
<i>H. latilabris</i> (Lindl.) J.D.Hook.	I	1, 7, 9	2700-3500	Ind Or	V	Leaf, Tuber	-
<i>H. marginata</i> Coleb.	II	1, 2	1300-1500	Ind Or	E	Tuber	For curing flatulence
<i>H. pectinata</i> (J.E.Sm.) D. Don.*	II	1, 2	1500-2000	Reg Himal	V	Leaf, Roots	For curing joint pains
<i>Herminium lanceum</i> (Thunb. ex Sw.) Vujik	I, II	1, 2, 7, 9	1810-3200	Reg Himal	V	Aerial Part	For curing urinary problems
<i>H. monorchis</i> (L.) R.Br.	I	1, 9	2900-3300	Europe As Bor	CR	Aerial Part	As tonic

Table 1. Diversity, distribution, indigenous uses and conservation of orchids in Himachal Pradesh (contd.).

Taxa Indigenous uses	Study Sites	Habitat(s)	Altitudinal range (m)	Nativity	Status	Part(s) used
<i>Listera pinetorum</i> Lindl.	II	1, 3	2600-3050	Reg Himal	-	-
<i>L. tenuis</i> Lindl.	II	1, 2	2810-3050	Reg Himal	Tubers	For curing skin diseases
<i>Malaxis acuminata</i> D. Don	II, III	1, 2, 7	1600-2200	Reg Himal	E	Stem/Leaf
<i>M. muscifera</i> (Lindl.) Ktze.	I, II, III	1, 5, 7, 9, 10	1500-3600	Europe	CR	Bulb
<i>Nervilia prainiana</i> (King & Pantl.) Seidenf.	IV	1	700-900	Reg Himal	V	Stem/Leaf
<i>Ophrys lancea</i> Thunb. ex Sw.	III	3	1972-2140	Java	-	-
<i>Rhynchostylis retusa</i> (Lindl.) Bl.	IV	11	700-900	Ind Or Malaya	V	Leaf, Root
<i>Satyrium nepalense</i> D. Don*	II	4, 8	1600-2500	Ind Or	NT	Tuber
<i>Spiranthes spiralis</i> Koch.	II	4, 8	1500-2200	China As Temp	V	Tuber
<i>Vanda cristata</i> Lindl.	III, IV	11	1600-1900	Reg Himal	NT	Leaf
						As a tonic and for curing cough, bronchitis, tonsillitis

Abbreviations used: I, Hirb and Shoja Catchments; II, Chailchowk-Ruhanda-Kamrunag Area; III, Shimla-Ghanahatti Area; IV, Mandi-Pandoh Area CR; Critically Endangered; E, Endangered; V, Vulnerable; NT, Near Threatened; Afr, Africa; As, Asia; Bor, Boreal; Himal, Himalayan; Ind, India; Or, Oriental; Reg, Region; Temp, Temperature; \*, Near endemic; \*\*, Endemic; 1, Shady Moist; 2, Riverine; 3, Degraded; 4, Dry; 5, Bouldary; 6, Rocky; 7, Shrubbery; 8, Grassland; 9, Moist Alpine Slope; 10, Dry Alpine Slope and 11, Epiphytic.

threat status based on population assessment and other parameters (population assessment, habitat specificity) was considered as one of the basic tasks of conservation strategies. International Union for Conservation of Nature (IUCN) Red Lists, and CAMP (Conservation Assessment and Management Plan) workshops at regional levels has played a crucial role in guiding the conservation priorities (Ved *et al.*, 2003). Many species which are enlisted under various threat categories as per IUCN may well flourish in one or other local regions. This deviation in the threat status in various regions suggested that location specific species assessment and conditions must be taken into account while assessing the status of a particular species. Consequently, it has become essential to assess the biodiversity for threat categories and prioritize locally (Lal, 2007; Rana and Samant 2010; Sakshi, 2009; Sharma, 2008). Various attempts in the Indian Himalayas have been made so far with a view to identifying the status of threatened plants using qualitative attributes (Badola and Pal, 2003; Pangtey and Samant, 1988, Samant *et al.*, 1993, 1996). In Himachal Pradesh, the inhabitants living near the forests are largely dependent on forests for grazing, fuel, fodder, timber, medicinal and wild edible plants, *etc.* Due to continuous use of economically important species, their populations are degrading rapidly and habitat degradation has increased many folds (Samant *et al.*, 2007a,b) and affecting the populations of the orchids. These factors have destructively affected the natural populations of these orchid species, and the existence of many others is threatened. Setting priorities for the conservation of species is essential to develop the appropriate management strategies (Dhar *et al.*, 2000)

The habitats of Himachal Pradesh are highly diverse and host an important number of orchid species. Although they were highly disturbed in the last few years by the surrounding inhabitants that selectively extract fuel, fodder, timber and orchids. Primary conservation strategies concerning protection of wild orchid populations and their habitats should be formulated and executed in concern with local community and environmental authorities in order to stop the habitat loss of wild orchid populations. Consequently, study on habitat ecology of these species requires priority attention. In addition, mass scale propagation of these species would help in *ex situ* and *in situ* conservation. Though such studies have been initiated in orchids of Himachal Pradesh (Chauhan *et al.*, 2010, 2015; Pathak *et al.*, 2011b; Vij *et al.*, 1995) these are meager. Some species can be promoted in floriculture and can help in income generation and socio-economic upliftment of the stakeholders of the area. Above all awareness

among the inhabitants about the importance of orchids needs to be created through awareness programmes, training programmes, exposure visits, nature activity camps, *etc.*

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