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DIVERSITY, DISTRIBUTION, INDIGENOUS USES, AND THREAT STATUS OF ORCHIDS IN DISTRICT KINNAUR, HIMACHAL PRADESH, NORTHWESTERN HIMALAYAS

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Abstract

Orchids are unique and highly evolved group of plants which belong to the family Orchidaceae, one of the most diverse and largest families of flowering plants. Apart from their extensive utility in traditional medicine systems, these plants are famous for their beautiful flowers. Due to over exploitation, habitat degradation, and continuously changing climatic conditions, the natural populations of these species are declining fast. Therefore, the present study was conducted in the district Kinnaur, Himachal Pradesh, NorthWestern Himalayas so as to assess the orchid diversity, distribution, and their indigenous usage pattern. A total of 20 species of orchids representing 14 genera were recorded. Amongst these species, 13 were native to Himalayan region, 4 were endemic, and 1 was near endemic to Indian Himalayan Region. Most of the orchid species were found to grow in 2400-2900 m altitude. Moist shady forest, alpine meadows, grassy meadows and agricultural field bunds were the major habitats. Fifteen species were reported to be in indigenous usage and were used to cure different ailments; 5 species were in usage as vegetables or tonic. According to IUCN, 3 species *i.e., Cypripedium cordigerum, Dactylorhiza hatagirea,* and *Malaxis muscifera* and as per Conservation Assessment and Management Prioritization (CAMP), 4 species *i.e.*, *Dactylorhiza hatagirea*, *Habenaria intermedia, Herminium edgeworthii,* and *Malaxis muscifera* are threatened and require conservation and management efforts.

Introduction

ORCHIDS ARE nature's one of the most beautiful creations, which is symbol of royalty and aristocracy in floriculture. The family Orchidaceae is amongst the most evolved families of flowering plants (Dressler, 1993; Tremblay *et al*., 2005); a total of 29,481 orchid species and 703 genera are reported throughout the world (POWO, 2024; WFO, 2023). Orchids are found in diverse climatic conditions but maximum diversity is found in tropical regions. These are distributed all over the world except Antarctica and their major diversity occurs in Tropical America, Indo-Malaya, and in India mainly in Eastern Himalayas. India is a country with one of the richest diversity of orchids with 1,256 species belonging to 155 genera (Singh *et al*., 2019).

The IHR comprises of three biogeographic zones, eight bio-geographic provinces and extends from Jammu & Kashmir in the NorthWest to the Arunachal Pradesh in the East (Rodger and Panwar, 1988). It covers nearly 17% of the geographical area and 3.8% of India's population. It is one of the mega diverse regions of India and supports approximately 8,000 flowering plants (Samant *et al*., 1998). Tropical, sub-tropical, temperate, sub-alpine, and alpine are the main vegetation types (Sharma, 2013). IHR has repository of more than 900 orchid species (Chauhan, 1999; Deva and Naithani, 1986; Samant, 2002) and like other states of IHR, Himachal Pradesh has 85 orchid species (Vij *et al*., 2013) as terrestrial, lithophytes, epiphytes, and mycoheterotrophs. The diversity of orchids has been reported to decrease from NorthEast to NorthWest Himalayas because of its unique habitat, large altitudinal range, and diverse weather conditions (Barman *et al*., 2016; Deva and Naithani, 1986; Kumar *et al*., 2019; Marpa and Samant, 2012; Pangtey and Samant, 1991; Samant, 2009).

Apart from their ornamental value and constituting multibillion-dollar business (De and Pathak, 2015), these plants are extensively used in traditional systems of medicine (Pathak *et al*., 2010; Samant, 2002). The therapeutic uses of orchids are due to the presence of phytochemicals *i.e.,* alkaloids, glycosides, flavonoids *etc*. (Hossain, 2011). The changing environmental conditions, land use patterns, over grazing, over-exploitation, and expanding urbanization have resulted in shrinkage and degradation of natural habitats causing threat to floristic diversity, including orchids. In general, a few studies have been carried out on orchids of IHR (Arora, 1986; Pangtey and Samant, 1991; Pangtey *et al*., 1991; Samant, 2002; Singh and Hajra, 1996; Vij *et al*., 1983).

In Himachal Pradesh, most of the orchids are used by local inhabitants mainly for their medicinal properties and for food (Kumari and Pathak, 2020; Pathak *et al*., 2010; Pathak *et al*., 2011; Samant *et al*., 1998). In Himachal Pradesh, some systematic studies of floristic

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diversity have been made by some workers (Chowdhery and Wadawa, 1984; Collet 1902; Dhaliwal and Sharma, 1999; Kaur and Sharma, 2004; Singh, 2018; Singh and Rawat, 2000; Singh and Sharma, 2006), studies on orchids have been made only by a few workers (Barman *et al*., 2021; Devi *et al*., 2018; Dutt *et al.,* 2023; Jaryal and Pathak, 2021; Jaryal *et al.,* 2021; Jyoti and Samant, 2023; Kumar *et al*., 2019; Marpa and Samant, 2012; Prakash, 2023; Prakash and Pathak, 2019; Prakash *et al*., 2018; Sharma and Samant, 2017; Sharma *et al*., 2017a,b; Singh *et al*., 2019; Verma *et al.,* 2023). Review of literature revealed that orchid diversity of district Kinnaur of Himachal Pradesh has not been studied as yet in detail. Therefore, the present attempt has been made to study the orchid diversity, distribution, indigenous usage pattern, and conservation status, so as to suggest management options.

Material and Methods

Extensive field surveys were carried out in different villages and valleys of district Kinnaur, Himachal Pradesh (mainly Nichar, Bari, Kalpa, Ribba, Purbani, Moorang, and Tangling villages and Bawa, Rupi, Baspa, Ropa, Hangrang, Lippa Asrang, Tidong and Pooh valleys) during 2015-2023. The study area lies between 31°06'-32°06'N latitudes and 77°45'-79°00'E longitudes. The elevation range of this district is 1320 to 7025 m above mean sea level. Total geographical area of Kinnaur district is 6400 km^2 and on the basis of climatic conditions, Kinnaur is divided into four zones *i.e*., wet (*i.e*., Nichar and Sangla), dry (*i.e*., Kalpa and Morang), semiarid (*i.e.,* Area south of the Great Himalayan range), and arid (Pooh) characterized by heavy snowfall during winter months (Fig. 1). This district has alpine, subalpine, and temperate vegetation and prominent tree species of the area are *Abies spectabilis*, *Alnus nitida, Betula utilis, Cedrus deodara*, *Fraxinus xanthoxyloides*, *Juniperus polycarpos*, *Piceas mithiana*, *Pinus gerardiana*, *P. wallichiana*, and *Quercus ilex*. For the information collection on orchid species, oral interviews, personal observations, and conversations with locals were used. Usual personal observations, oral interviews, and discussions with the villagers and amchis were the bases of collection of data about the orchid species. From each village, knowledgeable persons were interviewed through semi-structured questionnaires. The knowledgeable tribal people were those who have been using wild edible plants for the last 30-40 years. One knowledgeable person was hired from each village for the collection of fresh samples of the orchid species. The gathered samples were taken to the

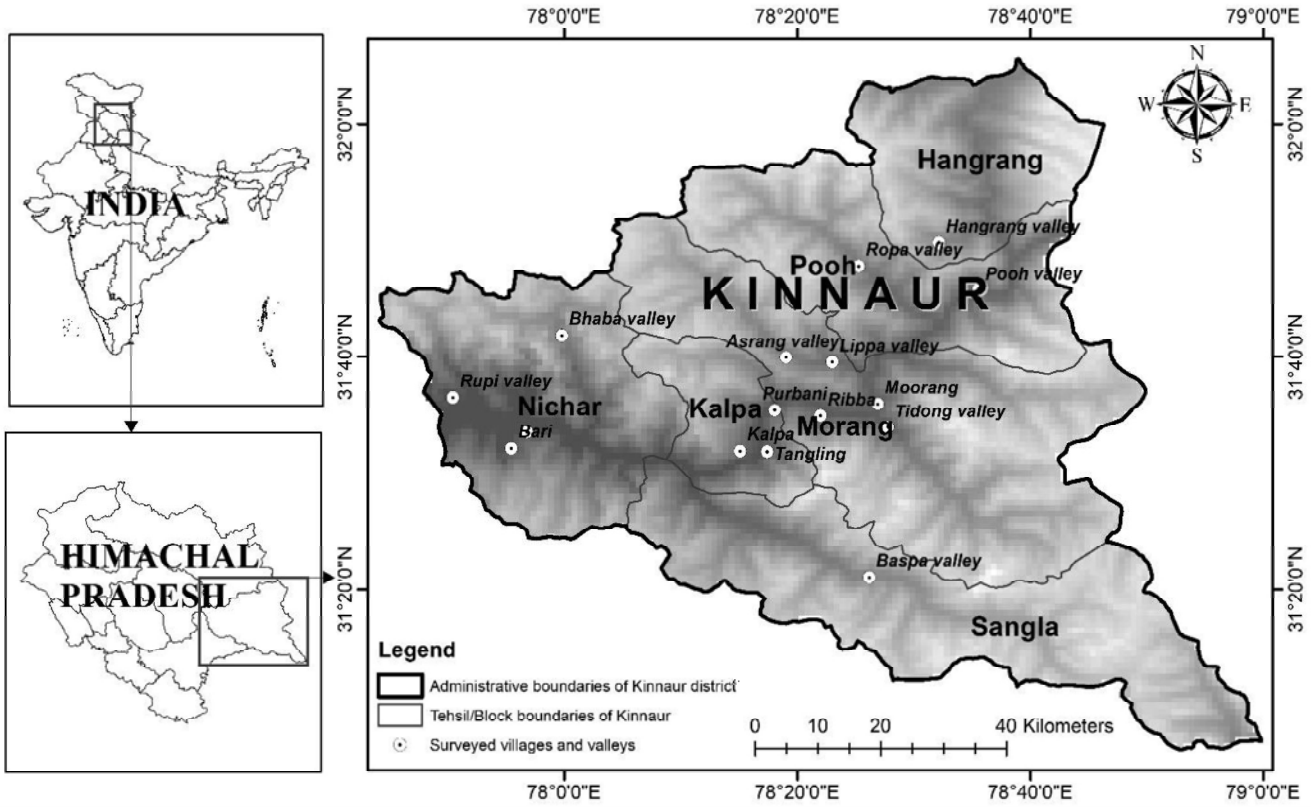

Fig. 1. Map of the study area showing selected villages in district Kinnaur, Himachal Pradesh, NorthWestern Himalayas.

institution for identification and these were identified using regional floras (Chowdhery and Wadhwa, 1984; Collet, 1902; Dhaliwal and Sharma, 1999; Kaur and Sharma, 2004; Singh, 2018; Singh and Rawat, 2000; Singh and Sharma, 2006). All identified species were listed and analyzed for diversity following Samant *et al*. (1998). Index Kewensis, The World Flora Online, International Plant Name Index were followed for nomenclature and nativity (Anonymous, 1885). Native species were those that originated or were first reported in the Himalayan region. Species endemism was determined based on species distribution. The species found only in the Himalayas have been regarded as endemic, while those found in adjacent countries were classified as near-endemic (Dhar and Samant, 1993; Rana and Samant, 2011; Samant *et al*., 1998). Conservation status of orchid species was determined as per IUCN and CAMP 2013 (Goraya *et al*., 2013).

Results

Species Diversity and Distribution Pattern

In total, 20 species of the orchids representing 14 genera were presently recorded in different habitats *i.e*., alpine meadows, shady moist forest, grassy meadows, shrubberies, riverine, agricultural field bunds, and moist forest. Genera *Habenaria* and *Herminium* represented the maximum diversity with 3 species each followed by *Crepidium* and *Epipactis,* each with 2 species. Ten genera namely, *Calanthe, Cephalanthera, Dactylorhiza, Goodyera, Liparis, Malaxis, Neottia, Oreorchis, Satyrium,* and *Spiranthes* were represented by single species. Of these, 8 species were recorded from altitudinal range below 1900m, 13 species in 1901-2300 m, 16 species in 2301-2700 m, 17 species in 2701-3100 m, and 11 species in above 3101 m altitudinal range (Table 1; Fig. 2). Overlapping of the species within above altitudinal zones has been also observed.

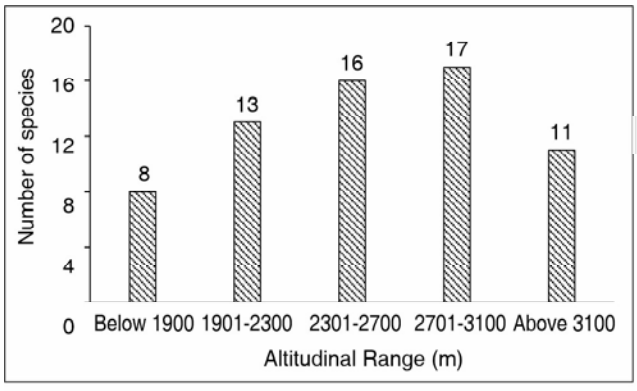

Fig. 2. Altitudinal distribution of orchids in district Kinnaur, Himachal Pradesh, NorthWestern Himalayas.

Nativity and Endemism

Thirteen species namely *Calanthe tricarinata, Crepidium acuminatum, Cypripedium cordigerum, Epipactis helleborine, E. veratrifolia, Habenaria intermedia, H. ensifolia, H. pectinata, Herminium lanceum, Liparis rostrata, Malaxis muscifera, Neottia listeroides,* and *Satyrium nepalense* were native to IHR. Three species namely *Dactylorhiza hatagirea, Goodyera repens,* and *Oreorchis indica* were native to IHR and other countries together. Four species namely *Cephalanthera longifolia, Herminium edgeworthii, H. monorchis,* and *Spiranthes sinensis* were non-native. Five species namely *Calanthe tricarinata, Cypripedium cordigerum, Habenaria ensifolia, H. pectinata,* and *Satyrium nepalense* were endemic and 1 species namely *H. intermedia* was near endemic to the IHR (Table 1; Fig. 3).

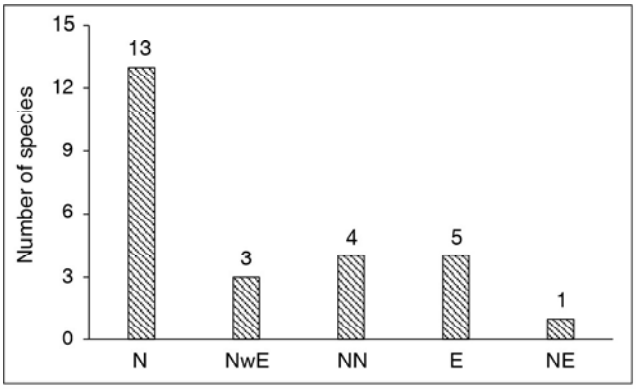

Fig. 3. Diversity of Native (N), Native with Extension (NwE), Non Native (NN), Endemic (E) and Near Endemic (NE) orchids in district Kinnaur, Himachal Pradesh, NorthWestern Himalayas.

Threat Status

Of the total species, 1 species *i.e*., *Dactylorhiza hatagirea* was identified as Endangered (EN); 2 species namely *Cypripedium cordigerum* and *Malaxis muscifera* were Vulnerable (VU) and 2 species namely *Epipactis veratrifolia* and *Spiranthes sinensis* were Least Concern (LC) as per International Union for Conservation of

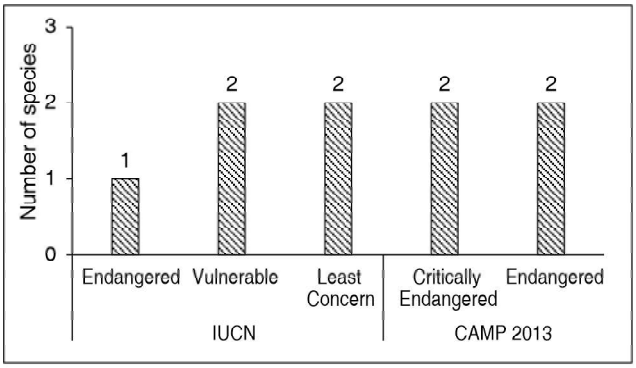

Fig. 4. Threat status of the orchids in district Kinnaur, Himachal Pradesh, NorthWestern Himalayas.

Nature (IUCN). As per Conservation Assessment and Management Prioritization (CAMP) report, 2013 of Himachal Pradesh State Forest Department, two species namely *Dactylorhiza hatagirea* and *Herminium edgeworthii* were critically endangered (CR) and two species namely *Habenaria intermedia* and *Malaxis muscifera* were endangered (EN) (Fig. 4).

Indigenous Uses

Of the total recorded orchid species, most of the species are used by local inhabitants to cure various ailments such as wounds, skin problems, sterility, leucorrhoea, sexual debility, neuropathy, mental problems, paralysis, blood related problems, arthritis, bone fracture, joint pain, snakebite, hernia, diabetes, dysentery, diarrhoea, typhoid, cough, cold, fever, stomachache, joint pain, cough, and throat infection. Local communities use different plant parts *i.e.*, leaf (5 spp.), root (4 spp.), tuber (1 sp.), bulb (1sp.), pseudobulb (3 spp.), rhizome (2) and whole plant (1 sp.) for curing various health problems (Fig. 5). Table 1 indicates the species with their common name, flowering period, altitudinal range, habitat, nativity, plant part used and medicinal use(s) of orchids in district Kinnaur of Himachal Pradesh, NorthWestern Himalayas.

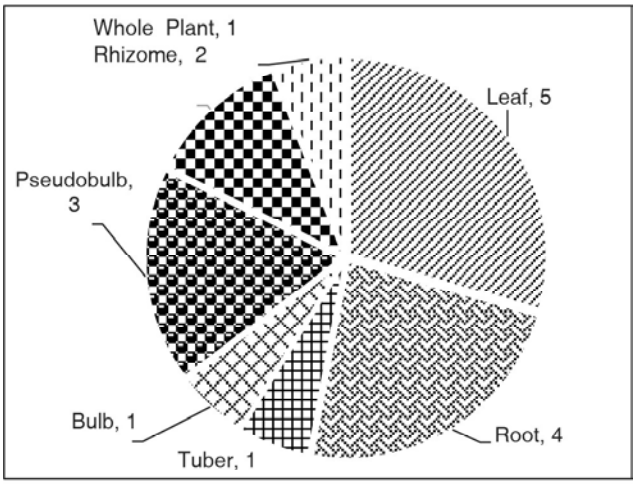

Fig. 5. Plant part(s) of orchids used for medicinal purpose in Kinnaur district of Himachal Pradesh.

Discussion

The occurrence of representative, natural, unique, and socioeconomically important orchids in the study area *i.e.,* district Kinnaur, Himachal Pradesh, NorthWestern Himalayas indicates high conservation and socio-economic values and needs high attention for conservation of these species. Earlier, a few studies have been made on different aspects including diversity, morphology, substratum analysis, soil profiling, medicinal potential, propagation, and conservation of orchids in some other districts of Himachal Pradesh (Jaryal and Pathak, 2021; Jaryal *et al*., 2021; Kumari and Pathak, 2020, 2021; Lal and Pathak, 2020; Lal *et al*., 2021; Pathak *et al*., 2010; Prakash and Pathak, 2019; Sunita *et al*., 2021; Thakur and Pathak, 2021; Vasundhra *et al*., 2021; Verma *et al*., 2009, 2015; Vij *et al*., 2008) and conservation measures have been suggested. Since orchids are habitat specific plants and require peculiar environmental conditions for their survival, they are generally found in specific elevation ranges and forest types. Some orchids are naturally rare because of their narrow geographic distribution and restricted habitat range, and low-density populations (Prakash and Pathak, 2019). Orchids are considered as symbol of friendship, perfection, fertility, nobility, and elegance (Reinikka, 1995) and also used in various Ayurvedic, Siddha, Yunani, Homeopathy, and Chinese medicine systems for curing various health problems from ancient time (Pathak *et al*., 2010). In India, *Acampe praemorsa*, *Coelogyne henryi, C. punctulata*, *Crepidium acuminatum, Cymbidium elegans, Cypripedium pubescens*, *Dendrobium monticola*, *Gastrodia elata*, and *Vanda testacea* are used to cure various ailments and available literature validates the observations (Handa, 1986; Lawler, 1984). The systemic studies of orchid in the IHR have shown that diversity of the orchids decreases from Eastern Himalayas to Trans, NorthWestern Himalayas (Deva and Naithani, 1986; Pangtey *et al*., 1991). As compared to states of Western, Central and Eastern Himalayas, Himachal Pradesh is less diverse in orchid diversity (Deva and Naithani, 1986; Samant, 2002). Except for the five epiphytic orchids namely *Aerides multiflora, Dendrobium amoenum, Gastrochilus calceolaris, Rhynchostylis retusa,* and *Vanda cristata,* all the other species are terrestrial (Deva and Naithani, 1986; Rana *et al.,* 2008). Several species that have been reported earlier from the region have not been recollected, which clearly indicates their disappearance due to habitat changes (Jalal, 2012). As the majority of orchids are insect pollinated, the depletion in the population of insect pollinators may also be one of the reasons for disappearance of such orchid species from their natural habitats (Prakash and Pathak, 2020, 2022).

The Kinnaur district of Himachal Pradesh lies in Trans and NorthWestern Himalayan region of India. Due to heavy snowfall during winters, the region remains geographically isolated from the rest of the country and inhabitants are highly dependent on the forest resources mainly for fodder, fuel, timber, Chilgoza seeds, medicines, spices, vegetables *etc*. (Lata *et al.,* 2023). During the present study, a total of 20 orchid species were recorded from district Kinnaur (Fig. 6) and

information on distribution pattern, nativity, endemism, indigenous uses, and threat status were also documented. Amongst the total species found, 13 species were natives; 5 species were endemic and 1 species was near endemic which indicates the importance of the area from conservation point. Most of the species are used by local people in indigenous medicines to cure variety of human ailments. The orchid species such as *Cypripedium cordigerum, Dactylorhiza hatagirea, Habenaria intermedia, Herminium edgeworthii,* and *Malaxis muscifera* were considered as threatened as per IUCN and CAMP. Currently, due to the establishment of large number of pharmaceutical units such as Divya, Dabur, Himalaya, *etc*., in Himachal Pradesh and Uttarakhand, the demand of these orchids has been increased many times (Kant *et al*., 2012). Market demand of *Crepidium acuminatum, Habenaria intermedia, Herminium edgeworthii,* and *Malaxis muscifera* is very high as these plants are used in preparation of various rejuvenating tonics in Ayurveda, serving as an important constituent of Ashtavarga (energy booster, stress reliever, and to boost immune system). Along with this, due to high medicinal and food value, *Dactylorhiza hatagirea* is also having huge commercial demand. All these species are facing high anthropogenic pressure, leading to rapid decline of

Fig. 6. A-E. Some of the orchids found in Kinnaur district, Himachal Pradesh: A, *Dactylorhiza hatagirea*; B, *Calanthe tricarinata*; C, *Herminium edgeworthii*; D, *Spiranthes sinensis*; E, *Herminium lanceum*.

Table 1. Species with their common name, flowering period, altitudinal range, habitat, nativity, plant part used and medicinal use(s) of orchids in district Kinnaur of Himachal Pradesh, NorthWestern Himalayas.

Species	Common name	Flowering period	Altitudinal range (m)	Habitat	Nativity	Plant part(s) used	Medicinal uses
Calanthe tricarinata Lindl.	Monkey orchid	May-July	1500-3500	Alpine meadows, Shady moist forest	Reg Himal	Leaf, Bulbs	Used as aphrodisiac and to cure wounds and itchy skin.
Cephalanthera longifolia (L.) Fritsch	Sword leaved Helleborine	May-June	1320-3500	Alpine meadows	EuropeAfr Bor As Temp	Root	Used as aphrodisiac, tonic and to cure wounds, cough and paralysis and itchy skin.
Crepidium acuminatum (D.Don) Szlach.	Jeevak	July-September	1400-2300	Shady moist forest	Reg Himal	Pseudobulb	Used as aphrodisiac tonic and to cure male infertility, burning sensation, neuropathy, fever and body weakness.
Cypripedium cordigerum D.Don	Heart-shaped Slipper Orchid	July-August	2800-4000	Alpine meadows	Reg Himal	Rhizome	Used as vegetable, tonic and to cure mental problems.
Dactylorhiza hatagirea (D.Don) Soó	Himalayan Marsh Orchid, Panch Ungli, Salampanja, Hathpanja	June-September	2500-4000	Grassy meadows, Shrubberies, Riverine, Alpine meadows and Agricultural field bunds	Reg Himal Europe Afr Bor Oriens	Tuber	Used as tonic and to cure blood related problems, bone fracture, wound infection, arthritis, cough, cold, fever, urinary, and sexual disability problems.
Epipactis helleborine (L.) Crantz	Broad leaved Helleborine	May-August	2500-3000	Moist forest, Riverine	Reg Himal	Leaf, Root	Used as aphrodisiac and to cure fever, stomachache, madness and arthritis.
E. veratrifolia Boiss. & Hohen.	Eastern Marsh Helleborine	May-June	2500-3600	Alpine meadows	Reg Himal	Rhizome	Used as aphrodisiac and to cure fever and blood related problems.
Goodyera repens (L.) R.Br.	Dwarf Rattlesnake Plantain, Creeping Lady's-Tresses	May-August	1300-3800	Shady moist forest, Alpine meadows	Reg Himal Bor Temp	Stem, Tuber	Used to stimulate hunger and to cure cold, urinary problems, blood related problems and sexually transmitted diseases.
Habenaria intermedia D.Don	Vridhi	July-August	1500-2600	Shady moist forest	Reg Himal	Tuber, Leaf	Used as tonic and to cure sterility. Young roots and tubers are also eaten as vegetable.
H. ensifolia Lindl.	Sword-Leaf Habenaria	July-August	1400-3000	Shady moist forest	Reg Himal	-	-
H. pectinata D.Don	Comb Habenaria, Safed Musli	July-September	1300-2500	Moist forest, Agricultural field bunds, Riverine	Reg Himal	Root, Leaf	Used to cure arthritis, joint pain and snake bite.

Table 1. Species with their common name, flowering period, altitudinal range, habitat, nativity, plant part used and medicinal use(s) of orchids in district Kinnaur of Himachal Pradesh, North Western Himalayas (contd.).

Species	Common name	Flowering period	Altitudinal range (m)	Habitat	Nativity	Plant part(s) used	Medicinal uses
Herminium lanceum (Thunb. ex Sw.) Vuijk	Lance leaf Herminum	July-September	1500-3000	Shady moist forest, Riverine, Agricultural field bunds, Alpine meadows	Reg Himal	Pseudobulb	Used to cure urinary problems, cold, fever, typhoid, arthritis, itchy skin, hernia, snake bite, swelling.
H. monorchis (L.) R.Br.	Musk Orchid	July-August	3000-3500	Moist forest, Riverine, Alpine meadows	Europe As Bor	Whole plant	Used as tonic.
H. edgeworthii (Hook.f. ex Collett) X.H.Jin, Schuit., Raskoti & Lu Q.Huang	Edgeworth's Habenaria, Riddhi	July-September	2500-3000	Shady moist forest	Ind	Root, Leaf	Used for purification of blood, restoration of youthful vigor and sexual disability.
Liparis rostrata Rchb.f.	Beaked Widelip Orchid	July-August	2200-2900	Moist forest	Reg Himal	-	-
Malaxis muscifera (Lindl.) Kuntze	Fly Bearing Malaxis	June-August	2100-3600	Moist forest, Agricultural field bunds, Riverine	Reg Himal	Pseudobulb	Used as tonic for aphrodisiac properties and to dysentery, weakness, burns and sterility.
Neottia listeroides Lindl.	Listera-Like Neottia	July-September	3000-3500	Moist forest, Riverine, Alpine meadows	Reg Himal	-	-
Oreorchis indica (Lindl.) Hook.f.	Indian Oreorchis	May-July	2300-2800	Shady moist forest	Reg Himal, China, Japan	-	-
Spiranthes sinensis (Pers.) Ames	Chinese Lady's-Tresses	July-August	2100-3700	Grassy meadows, Agricultural field bunds	China As TempAus Europe	Tuber	Used as tonic and to acute throat infection, wounds, snakebite, diarrhoea, cough, cold leucorrhoea, diabetes and tuberculosis.
Satyrium nepalense D.Don	Nepal Satyrium	July-September	1900-4000	Grassy meadows, Agricultural field bunds	Reg Himal	Tuber	Used as vegetable and tonic due to aphrodisiac properties and to cure dysentery and swelling in the scrotum.

natural population in the area due to high commercial, medicine and food value. In future, if over exploitation and habitat degradation continues, these species may likely become extinct from the area. Thus, for the conservation, sustainable management and to fulfill commercial demand of high medicinal value orchid species, the population assessment, habitat monitoring w.r.t climate change, development of sustainable harvesting methods, development of mass multiplication procedures, cultivation techniques, education and awareness programmes for local communities are suggested.

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