

ORCHIDS OF WATER CATCHMENT WILDLIFE SANCTUARY, SHIMLA (HIMACHAL PRADESH), NORTHWESTERN HIMALAYAS: THEIR DIVERSITY, STATUS, INDIGENOUS USES, AND CONSERVATION STATUS

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Abstract

Orchidaceae is amongst the most diverse and widespread families of flowering plants. They are known for their incredible diversity in size, shape, forms, colour, attractiveness of their flowers and high keeping qualities upto ten wks. The Eastern Himalayas (including the NorthEast India), the Western Ghats, and the Western Himalayas are the three major centers of orchid diversity in India with a total strength of about 1,256 species of orchids in 155 genera. Presently, an attempt was made to assess the diversity, distribution, threat status, indigenous uses, and conservation status of orchids of Water Catchment Wildlife Sanctuary, Shimla (Himachal Pradesh), NorthWestern Himalaya. A total of 10 orchid species under 7 genera (*Cephalanthera*, *Epipactis*, *Habenaria*, *Herminium*, *Liparis*, *Malaxis*, and *Satyrium*) belonging to sub-families Orchidoideae and Epidendroideae have been collected from the study area. All of the species were found to be primarily distributed at an elevation range of approximately 1900-2620 m above the sea level. These have medicinal properties and are used to cure several diseases like sores, eczema, blood disorders, skin disorders, fever, male sterility, internal haemorrhage, rheumatism, bronchitis etc. These are also used as tonic, aphrodisiac, rejuvenator, spermoprotic etc. As most of the orchids are insect pollinated, the depletion in the populations of insect pollinators may also lead to the depletion in the natural populations of particular orchid species. Further, as these are important both scientifically and commercially, their natural populations are on decline due to lot of other commercial pressures as well besides habitat destructions due to various natural and anthropogenic reasons. Amongst the presently studied species, *Habenaria edgeworthii*, *Herminium lanceum*, and *Liparis rostrata* are categorized as Endangered; *Malaxis muscifera* as Vulnerable; *Habenaria intermedia*, *Malaxis acuminata*, and *Satyrium nepalense* are Near Threatened; and *Cephalanthera longifolia*, *Epipactis helleborine*, and *Habenaria latilabris* as Least Concerned. Therefore, several conservation measures are being suggested and orchid species are under the protection of the Convention on International Trade in Endangered Species of Wild Fauna and Flora and enlisted in the appendices I & II of CITES (2012).

Introduction

THE ORCHIDS, flowers of exquisite beauty belong to one of the largest families of angiosperms, the Orchidaceae, which represents the most highly evolved family amongst monocotyledons with 28,237 species (Willis, 2017). In a more recent report, however, the Royal Botanic Garden of Kew lists 880 genera and nearly 22,000 accepted species, but the exact number is unknown because of taxonomic disputes. They are virtually found in all regions around the globe except the icy Antarctica and hot deserts, but their greatest diversity occurs in the tropical and sub-tropical regions. The Eastern Himalayas (including the NorthEast India), the Western Ghats, and the Western Himalayas are the three major centers of orchid diversity in India with a total strength of about 1,256 species of orchids in 155 genera (Singh *et al.*, 2019). The great geographic expanse of the country encompassing a variety of bioclimatic zones and the enormous diversity of ecosystems accounts for the bewildering array of orchid species in India. Orchids are undoubtedly the ornamental elite because of their perplexingly complex flowers of exquisite beauty. Reason being, orchids nowadays became an object of multibillion dollar business (De and Pathak, 2015). Apart from their ornamental value, many

orchids also have apparent medicinal importance (Kumar *et al.*, 2018; Pathak *et al.*, 2010; Prakash *et al.*, 2018).

These plants are habitat specific and slow growing. Some orchid species require unique habitat and microhabitats so they are confined to particular elevations and forest types. Some are naturally rare; others are so because of geographic distribution, narrow habitat requirements, and low-density populations. Several species that have been reported earlier from the region have not been recollected, thus indicating their possible disappearance due to habitat changes (Jalal, 2012). As most of the orchids are insect pollinated, the depletion in the population of insect pollinators may also lead to the depletion in the population of particular orchid species. Further, as these are important both scientifically and commercially, their natural populations are on decline due to lot of commercial pressures besides habitat destructions due to various natural and anthropogenic reasons. Several conservation measures are being suggested and these are under the protection of the Convention on International Trade in Endangered Species of Wild Fauna and Flora and enlisted in the appendices I & II of CITES (2012).

The Indian Himalayan region (IHR), one of the richest bio-geographic zones of India stretches about 3,000

km in length and 220-300 km in width. 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 about 8,000 flowering plants species (Kumar *et al.*, 2016; Samant *et al.*, 1998; Singh and Hajra, 1996). Like other parts of IHR, orchids of Himachal Pradesh are well known for their charming beauty and utility (Barman *et al.*, 2016). Water Catchment Wildlife Sanctuary is one of the most popular sanctuaries of Shimla, the capital of Himachal Pradesh. The sanctuary is blessed with limitless species of flora and fauna gifted by the Mother Nature. Bounties of wildlife, trees, plants, and herbs *etc.*, make the sanctuary paradise for the nature watchers. People keep coming here to enjoy wildlife in their natural posture. The place is not only famous for providing some of the best sightings for common and rare wildlife, but it is also the major source of water supply to the city of Shimla. The maximum area of the sanctuary is covered with Cedar, Oak, and Pine trees. The flora in this sanctuary mainly consists of temperate coniferous trees. More than half of the sanctuary area is covered with grasses, but vascular herbs and ferns are also found here. During the present explorations in the region, 10 species of orchids were observed, though their richness was relatively low. Earlier, some studies on orchid diversity have been carried out in Himachal Pradesh (Arora, 1986; Chowdhery and Agrawala, 2013; Barman *et al.*, 2016; Deva and Naithani, 1986; Devi *et al.*, 2018; Kant *et al.*, 2012; Prakash *et al.*, 2018; Duthie, 1906; Kumar *et al.*, 2016, 2017, 2018; Marpa and Samant, 2012; Samant, 2002; Sharma *et al.*, 2015, 2017; Verma *et al.*, 2013; Vij *et al.*, 2013). In general, mention of orchids of Himachal Pradesh has also been made in the floristic studies by some workers (Chowdhery and Wadhwa, 1984; Collett, 1902; Dhaliwal and Sharma, 1999; Kaur and Sharma, 2004; Rana *et al.*, 2008; Sharma, 2008, 2013; Singh and Rawat, 2000; Singh and Sharma, 2006), but a very few studies are available for the protected areas of the state (Barman *et al.*, 2016; Devi *et al.*, 2018; Kumar *et al.*, 2017, 2018; Sharma *et al.*, 2015). Therefore, presently an attempt was made to; i) assess the orchid diversity in Water Catchment Wildlife Sanctuary (Shimla); ii) analyze their status and threat categories; and iii) assess their indigenous uses and conservation status.

Material and Methods

Study Site

Water Catchment Wildlife Sanctuary is located between $31^{\circ}05'12''$ - $31^{\circ}07'11''$ N and $77^{\circ}12'54''$ - $77^{\circ}16'04''$ E in Shimla District of Himachal Pradesh. The sanctuary is spread over an area of 10.25 sq km (Fig. 1). The altitude ranges from 1900-2620 m amsl and the range of temperature is -5.4°C - 32°C . The Sanctuary receives annual rainfall of about 1600 mm. Winter experiences severe cold and main precipitation is in the form of snow. Rains are mostly confined to summer and rainy seasons. Nine perennial streams flow from this area, the main ones being Churat Nala and God Ki Nala. The forest was declared a Protected Forest in 1952; and was finally notified as a Wildlife Sanctuary in 1999. Till year 2006, it was under the administrative control of the Municipal

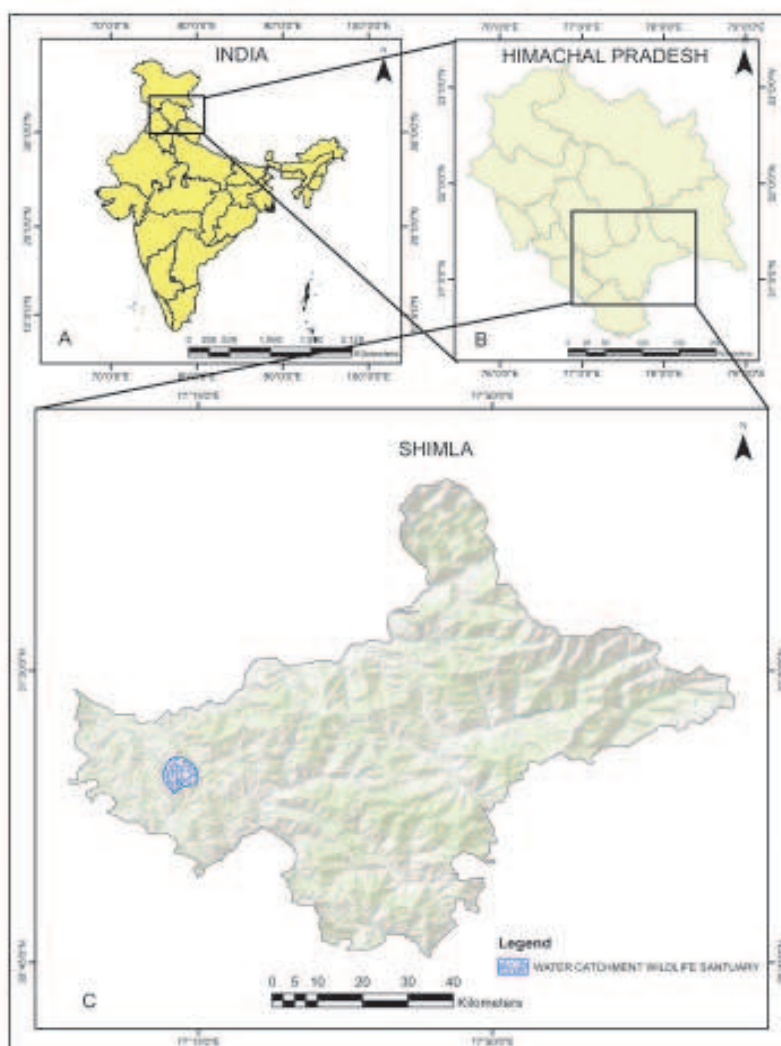


Fig. 1 A-C. Map of study area in Shimla district of Himachal Pradesh: A, Map of India; B, Map of Himachal Pradesh; C, Map of Shimla district showing Water Catchment Wildlife Sanctuary.

Corporation of Shimla, and was handed over to the Wildlife Division of Shimla in 2009. The catchment area is rich in biodiversity, home to many species of plants, animals, birds, and insects. Many plants of medicinal importance are also found in the forest. The vegetation of this area consists predominately of temperate coniferous forest, dominated by Himalayan Cedar (Deodar), and mixed at lower elevation with White Oak and patches of Chill Pine, and at higher elevation with blue pine. An average of about 50% cover ground vegetation is predominately grasses, but includes a variety of ferns and vascular herbs. Forest type includes Himalayan Subtropical Pine Forest; Lower Western Himalayan Temperate forest, Ban Oak Forest, moist Cedar Forest, which cover the major portion of this Sanctuary.

Field Survey and Data Collection

Extensive surveys were conducted in Water Catchment Wildlife Sanctuary (Shimla) during June-September from 2016-2018. For each species encountered, field notes were taken such as date, locality, habitat preferences, associated vegetation and brief identification features. The species were identified by using floras and literature (Aswal and Mehrotra, 1994; Chowdhery and Wadhwa, 1984; Collett, 1902; Deva and Naithani, 1986; Dhaliwal and Sharma, 1999; Duthie, 1906; Pangtey *et al.*, 1991;

Singh and Rawat, 2000; Vij *et al.*, 2013). The species were also photographed in their natural habitats with the help of Nikon digital camera (COOLPIX P900; 16MP, 83x optical zoom) (Fig. 2).

Results

A total of 10 orchid species under 7 genera (*Cephalanthera*, *Epipactis*, *Habenaria*, *Herminium*, *Liparis*, *Malaxis*, and *Satyrium*) belonging to sub-families Orchidoideae and Epidendroideae have been collected from the study area (Table 1). Orchid species observed in the present study were adapted to terrestrial habitat mode. All of these species were primarily distributed at an elevation range of approximately 1900-2620 m above the sea level. The brief notes on morphology, distribution, flowering and fruiting period, habitat ecology, biological status, and indigenous uses of the presently studied orchid species were prepared.

Cephalanthera longifolia (L.) Fritsch

Plants 10-60cm. *Rhizome* short with numerous roots. *Stem* densely leafy. *Leaves* many, alternate, sessile, lanceolate to linear lanceolate, 5-6cm × 1.5-3cm, spreading. *Inflorescence* few-many flowered raceme. *Flowers* pure white, about 12mm long. *Sepals* lanceolate, upto 15-18mm long, *petals* smaller than

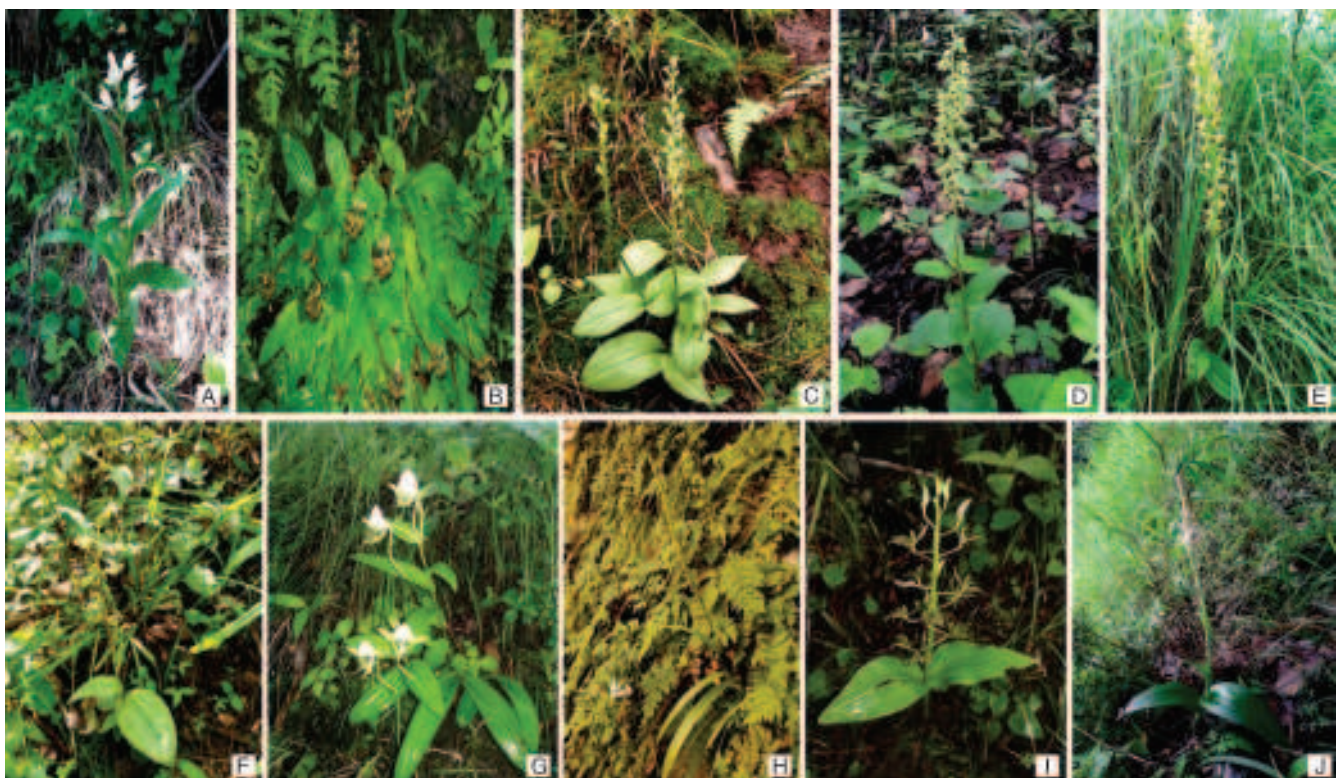


Fig. 2. A-J. Orchids of Water Catchment Wildlife Sanctuary, Shimla (Himachal Pradesh), NorthWestern Himalaya: A, *Cephalanthera longifolia*; B, *Malaxis acuminata*; C, *Malaxis muscifera*; D, *Epipactis helleborine*; E, *Habenaria edgeworthii*; F, *Habenaria latilabris*; G, *Habenaria intermedia*; H, *Herminium lanceum*; I, *Liparis rostrata*; J, *Satyrium nepalense*.

Table 1. Diversity, altitudinal range, habitat, threat status, and indigenous uses of orchids in Shimla Water Catchment Wildlife Sanctuary of Himachal Pradesh, NorthWestern Himalaya.

Species	Common name	Altitudinal range (m)	Habitat	Threat status	Part used	Indigenous uses and practices
<i>Cephalanthera longifolia</i> (L.) Fritsch.	Sword-leaved helleborine	2000-2560	T	LC	Tb, Lf	Decoction of the leaves and tubers is used to cure sores, eczema, and used as an aphrodisiac.
<i>Malaxis acuminata</i> D.Don	Jeevak	1940-2350	T	NT	Pb	Important ingredient of ashtavarga, used in chyawanprash (tonic), to cure blood disorders, burning sensation in the body, male sterility, fever, dysentery, external and internal haemorrhage, and general weakness. It is also used as an aphrodisiac, against insect bite, and rheumatism.
<i>Malaxis muscifera</i> (Lindl.) Ktze.	Rishbhak	2100-2600	T	VU	Pb	In addition to Chyawanprash, it is used as nutritive tonic, for curing bleeding diathesis, burning sensation, fever, phthisis, bronchitis, and tuberculosis. It also enhances sperm formation.
<i>Epipactis helleborine</i> (L.) Crantz.	Broad-leaved helleborine	2150-2550	T	LC	Rh, Lf	Used for curing fever, blood purification, and as an aphrodisiac.
<i>Habenaria edgeworthii</i> Hook. F. ex Collett	Vridhhi	2380-2600	T	EN	Tb, Lf	Decoction used as blood purifier, rejuvenator, cooling, and spermopiotic.
<i>Habenaria latilabris</i> (Lindl.) Hook.f.	Bog orchid	2200-2450	T	LC	Tb, Rt, Lf	Used in herbal medicine.
<i>Habenaria intermedia</i> D.Don	Riddhi	2200-2550	T	NT	Tb, Rt, Lf	Used as tonic, expectorant, rejuvenator, for curing fever, skin disease, and blood disorder.
<i>Herminium lanceum</i> (thumb. ex Sw.) Vujik	Jalya	2000-2360	T	EN	WP	The whole plant is medicinal and is used to treat cold and fever, rheumatism, typhoid fever, hernia, sores, eczema, snake bites, and for reducing swelling and pain. The extract of the plant is also given to cure suppressed urination.
<i>Liparis rostrata</i> Rchb. f.	Beaked white lip orchid	1990-2430	T	EN	Tb	For curing stomachache and malignant ulcers.
<i>Satyrium nepalense</i> D.Don	Salang mishri	2300-2600	T	NT	Tb	Used as tonic, and to cure diarrhoea, dysentery, and malarial fever. Fresh tubers are cooked and consumed, dried ones sold as 'salammisri' and regarded as tonic, juice of leaf used to cure fever, cuts and wounds. Fresh tuber considered as aphrodisiac. Tuber extract shows potent antibacterial activity against four bacterial strains <i>i.e.</i> , <i>Streptococcus mutans</i> , <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus aureus</i> , and <i>Klebsiella pneumonia</i> .

EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern; Tb, Tuber; Pb, Pseudobulb; Rz, Rhizome; WP, Whole plant; Lf, Leaf; Rt, Root; T, Terrestrial.

sepal, obtuse. *Lip* distinctly bilobed, hypochile with orange-yellow patch at base, concave with oblique-oblong side-lobes; epichile oval, papillose with 4-6 orange-yellow, parallel crests. *Column* slender, upto 8mm long. *Ovary* glabrous, sessile.

Distribution

Cephalanthera longifolia is well distributed throughout the Indian Himalayan region from Kashmir to Arunachal Pradesh at an altitudinal range of 1,800-3,200 m. Its distribution extends eastwards to Bhutan, South East Tibet, Burma and Japan (King and Pantling, 1898; Collett, 1902; Deva and Naithani, 1986). This species is widely distributed in Northern hemisphere as well. It is commonly found in much of Western and Southern Europe, where it is common in Southern France and Spain, but endangered particularly in Northern areas such as Belgium.

Flowering

May-July

Fruiting

July-August

Biological Status

Least Concern (LC)

Plant Part Used

Tubers and leaves.

Uses

Decoction of the leaves and tubers is used to cure sores, eczema, and used as an aphrodisiac

Habitat Ecology

Cephalanthera longifolia (commonly known as sword-leaved helleborine) is a terrestrial orchid, commonly found in much of Western and Southern Europe. It is well distributed throughout the Indian Himalayan region from Kashmir to Arunachal Pradesh at an altitudinal range of 1,800-3,200 m. Its distribution extends eastwards to Bhutan, South East Tibet, Burma and Japan (King and Pantling, 1898; Collett, 1902; Deva and Naithani, 1986). This species is widely distributed in Northern hemisphere as well. It typically grows in damp woodland places. It is found growing on calcareous soils in woodlands, but also occurs in rocky woodland and gorges. It prefers open well lighted situations. In the surveyed area, a number of populations (single, or in groups of 2-4 plants) were found growing on grassy slopes sharing the niches with

other herbaceous plants. Mosses, ferns, grasses, *Berberis* sp., *Rosa* sp. etc. form the associated vegetation. Amongst orchids, *Epipactis helleborine*, *Liparis rostrata*, and *Malaxis muscifera* were often found in its vicinity.

Epipactis helleborine (L.) Crantz

Plants slender or robust, pubescent, 25-100cm tall. *Rhizome* short fleshy. *Roots* numerous, fleshy. *Stem* leafy. *Leaves* 3-10, spreading, ovate to ovate-lanceolate, 5-18cm x 1.5-8cm. *Inflorescence* normally densely many-flowered raceme, upto 20-35cm long. *Floral bracts* spreading, linear to narrowly lanceolate, lower exceeding flowers, the upper decreasing in size, 10mm x 40-60mm. *Flowers* small, usually dark olive-green to yellowish-green in colour, sometimes tinged with red-purple. *Sepals* ovate-lanceolate; lateral sepal upto 12mm x 6mm; petals slightly shorter, ovate, paler green or pinkish. *Labellum* indistinctly veined, concave, constricted at middle into 2 lobes, *hypochile* cup-shaped, purplish to brownish, with nectar, 8-12mm x 7mm; *epichile* cordate, upto 5.5mm x 5mm, with 2 brownish bosses at base. *Column* short, 3-5mm. *Ovary* pedicelled, glabrous or with some hair; *capsule* spreading, obovoid, densely pubescent, 9-14mm.

Distribution

This species is widely spread in Himalaya from Pakistan to Nepal, Sikkim, and Bhutan at an altitudinal range of 1,500-4,000m. It is also a common species in Europe, North Africa, Afghanistan, Iraq, Japan, and China and has been introduced into the United States (Deva and Naithani, 1986; Chowdhery, 1998).

Flowering

June-July

Fruiting

July-August

Biological Status

Least Concern (LC)

Plant Part Used

Rhizome and leaves.

Uses

Besides being used as an aphrodisiac, it is used for curing fever and for blood purification.

Habitat Ecology

Commonly known as broad-leaved helleborine, this

species grows in diverse habitats, from moist to dry, rocky, open soils of deciduous and/or coniferous forests to shaded littered floor of deciduous and/or mixed forest. The distribution pattern is both of random and patchy type. In the surveyed area, it was found to grow as individual or in groups of 2-5 plants. It is also found to grow in meadows, cedar swamps, grassy slopes, and forested stream margins; often in disturbed places such as roadsides, lawns, and cracks in concrete sidewalks. For its well adaptability to a wide range of habitat, it's sometimes called the weed orchid. This species was common in the surveyed area and was collected from a number of locations where it was found to grow on exposed, moist, humus rich, somewhat loamy grassy slopes, road embankment, and forest borders. Grasses, ferns, mosses, members of Asteraceae, Labiatae, Leguminosae, pine seedlings, and orchid species including *Cephalanthera longifolia*, *Habenaria edgeworthii*, *H. intermedia*, *Herminium lanceum*, and *Malaxis muscifera* comprised its associated vegetations.

Habenaria edgeworthii Hook. f. ex Collett

Terrestrial, 25-70cm in height. *Tuberoids* small, fleshy. *Stem* leafy, stout, pubescent, somewhat flexuous. *Leaves* 2-4, the second largest, sheathing, slightly fleshy, ovate to ovate-lanceolate, 5-10cm × 4-4.5cm. *Inflorescence* dense, cylindrical, 25cm × 3cm. *Bracts* lanceolate, shorter than or equal to the ovary in length. *Flowers* crowded, yellowish green, deflexed in bud. *Sepals* green, pubescent, margins ciliolate, dorsal sepal concave, erect, broadly ovate, 3-4mm × 4-5mm, lateral sepals somewhat larger, oblong, 5-6mm long, deflexed. *Petals* brightly yellow to greenish-yellow, thick, obliquely triangular from a broad base, 5-6mm long, apically curved inwards, forming a hood with dorsal sepal. *Labellum* bright yellow, entire, 7-9mm long, strap-shaped, its base form a broad, slightly channelled claw, anteriorly deflexed, with a distinct protuberance on the flexion between the basal claw and the anterior section, 5-5.5mm × 1mm. *Spur* longer than ovary, yellowish green, upwardly spreading with tip hooked downwards. *Column* 2.5-3mm long, anther canals and stigmatic processes short. *Ovary* twisted, glabrous.

Distribution

Habenaria edgeworthii is found at an altitude of 1,500-3,000 m in the North West Himalayan region from Jammu and Kashmir to Kumaun. It is also found in Pakistan (Chowdhery and Wadhwa, 1984; Deva and Naithani, 1986).

Flowering

July-August

Fruiting

August-October

Biological Status

Endangered (EN)

Plant Part Used

Tubers and leaves.

Uses

Decoction used as blood purifier, rejuvenator, cooling, and spermopiotic.

Habitat Ecology

Habenaria edgeworthii grows in the temperate regions and common under semi shady to somewhat exposed situations. It is also found in open grasslands from low to high elevations. In presently surveyed areas, this species was found to grow alone or in small groups of 2-3 plants on exposed grassy slopes and road embankments. It shares the habitat with grasses, mosses and other herbaceous plants. Amongst orchids, *Epipactis helleborine*, *Habenaria intermedia*, *H. latilabris*, *Malaxis acuminata*, and *Satyrium nepalense* were found growing in its vicinity.

Habenaria intermedia D. Don

Terrestrial. *Plants* 28-50cm tall. *Tuberoids* oblong, sessile. *Stem* terete, evenly leafy. *Leaves* 3-5, ovate-oblong, alternate, nearly fleshy, acuminate, 5-7 nerved, upto 7-16cm × 2-5cm, sheathing. *Inflorescence* 1-6 flowered raceme. *Bracts* leaf like, lower longer than upper, upper one nearly equal to the ovary in length. *Flowers* large, greenish white or white, ca. 4.5cm across. *Sepals* persistent, green, the dorsal ovate-lanceolate, recurved, 2-2.4cm × 0.85-1cm, lateral-sepals falcately lanceolate, spreading, 2.2-3cm × 0.5cm. *Petals* white, semilunar shaped, recurved and attached to dorsal sepal, margins minutely ciliolate. *Labellum* pale green, 3-lobed, with a undivided, white base, 3-4cm in length; mid-lobe linear, acuminate, straight or slightly turned upwards, side lobes somewhat diverging, partly divided, with fine fringes on the outer margin. *Spur* green, 6 cm long, flexuous, with wide base and apex. *Column* ca. 7.5mm in height, footless. *Anther* filiform, directed upward, *pollinia* 2, elongate, *viscidium*. Stigmatic processes slender, incurved. *Ovary* 3-4cm long, slightly twisted. *Fruit* capsule, fusiform.

Distribution

In India, *Habenaria intermedia* is found at an altitude of 1,500-2,800 m in the Himalayan region from Jammu

and Kashmir to Sikkim and also in Meghalaya. It is also encountered in Pakistan and Tibet (Deva and Naithani, 1986).

Flowering

July-August

Fruiting

August-October

Biological Status

Near Threatened (NT)

Plant Part Used

Tubers, roots and leaves.

Uses

Used as tonic, expectorant, rejuvenator and for curing fever, skin disease, and blood disorders.

Habitat Ecology

This species grows in the temperate regions and common under semi shady to somewhat exposed situations. It is also found in open grasslands from low to high elevations. In presently surveyed areas, it was mostly found to grow individually or in groups of 2-10 plants on loamy to slightly sandy, exposed forest slopes. It shares the habitat with grasses, mosses, ferns, members of Asteraceae, and other herbaceous plants. Amongst orchids, *Epipactis helleborine*, *Habenaria edgeworthii*, *H. latilabris*, *Herminium lanceum*, and *Satyrium nepalense* were found to grow in its vicinity.

Habenaria latilabris (Lindl.) Hook.f.

Terrestrial, upto 40cm in height. *Tuberoïds* conical, fleshy, sessile. *Stem* stout, slender, somewhat flexuous. *Leaves* 3-4, spreading, alternate, slightly fleshy, scattered, elliptic to oblong, acuminate, 5-10cm x 2-3cm. *Inflorescence* laxly arranged and many flowered spike. *Floral bracts* lanceolate, longer than the ovary. *Flowers* crowded, green in colour. *Sepals* subequal, green, 3-5 nerved, margins ciliolate, dorsal sepal concave, erect, broadly ovate, smaller than the laterals, 3-4mm x 4-5mm, lateral sepals somewhat larger, oblong, 5-6mm long, reflexed. *Petals* green, equal to lateral sepals, linear from abroad triangular base, 5-6mm long, apically curved inwards forming a hood with dorsal sepal. *Labellum* green in colour, somewhat fleshy, longer than petals, entire, linear, 7-9mm long, strap-shaped, margin inrolled, gradually narrowing towards the apex. *Spur* longer than ovary, turned downwards or

sideways, never turned upwards. *Column* short, footless. *Anther*-canals short, curved forwards. *Pollinia* 2, granular. *Ovary* twisted, glabrous.

Distribution

Habenaria latilabris is found at an altitude of 1,800-4,000 m in the NorthWestern Himalayan region from Himachal Pradesh and Arunachal Pradesh. It is also found in Nepal and Bhutan (Deva and Naithani, 1986; Chowdhery, 1998).

Flowering

July-August

Fruiting

August-October

Biological Status

Least Concern (LC)

Plant Part Used

Tubers, roots and leaves.

Uses

Used in herbal medicine.

Habitat Ecology

This species grows in the temperate regions and is common under semi shady to somewhat exposed situations. It is also found in open grasslands from low to high elevations. In presently surveyed areas, this species was found to grow alone or in small groups of 2-3 plants on exposed grassy slopes and road-embankments. It shares the habitat with grasses, mosses and other herbaceous plants. Amongst orchids, *Epipactis helleborine*, *Habenaria edgeworthii*, *H. intermedia*, and *Satyrium nepalense* were found to grow in the vicinity.

Satyrium nepalense D.Don

Robust, terrestrial herb, 30-80cm tall. *Tuberoïds* oblong. *Stem* leafy below, densely covered with sheaths above, sometimes stoloniferous with a small tuberoïds at end. *Leaves* 2, rarely 4, lanceolate to elliptic, rather fleshy, 5-20cm x 1-8cm, acute, sheathed at base. *Inflorescence* densely flowered, terminal spike. *Scape* covered with largefoliacious bracts; *bracts* oblong-lanceolate, longer than ovary, the upper diminishing in size. *Flowers* small, rose-pink, occasionally pure white, musk-scented, 8-15cm across. *Perianth* segments recurved, sub-equal inlength, upto 7mm long; dorsal *sepal* linear-oblong; lateral sepals obliquely-oblong; *petals* linear, twisted at

the mouth of the lip. *Labellum* broad, oblong, erect, hooded, upto 8mm long, 10mm broad, with 2 parallel spurs at base, tapering into a fine point, variable and sometimes unequal in length, 10-15mm long. *Column* slightly curved.

Distribution

This species is abundant throughout Western Himalaya (1,500-3,000 m), and its distribution extended eastwards to Nepal, Sikkim, Bhutan, and to the Eastern Himalaya where it is ascending above 3,000 m-4,000 m. It is also reported from South India, Sri Lanka, Pakistan, East Tibet, Ceylon, North Burma, and China (King and Pantling, 1898; Deva and Naithani, 1986; Chowdhery, 1998).

Flowering

August-September

Fruiting

September-October

Biological Status

Near Threatened (NT)

Plant Part Used

Tubers and Leaves.

Uses

Used as tonic, and to cure diarrhoea, dysentery and malarial fever. Fresh tubers are cooked and consumed, dried ones sold as 'salammisri' and regarded as tonic. Juice of leaf is used to cure fever and cuts and wounds. Fresh tubers are considered as aphrodisiac. Tuber extract shows potent antibacterial activity against four bacterial strains *i.e.*, *Streptococcus mutans*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Klebsiella pneumonia*.

Habitat Ecology

Satyrium nepalense is a predominant species of the open grassy situations at low to high elevations. The species can sometimes be found in extensive and dense colonies of individuals in the sub-tropical to temperate Himalayan grassy slopes. It was usually encountered under open conditions but sometimes it was also available under partial shade. As in many other terrestrial orchids, the entire above-ground part of the plant dies at the end of the growing season and the plant becomes dormant. In the study area, it was found to grow singly or in groups of 2-6 individuals at grassy slopes under direct sunlight. Grasses, ferns, *Rumex*

sp. etc. represented associated vegetation. Amongst orchids, *Habenaria edgeworthii*, *H. intermedia*, *Herminium lanceum*, and *Liparis rostrata* were found to grow in the vicinity.

***Malaxis acuminata* D. Don**

Terrestrial. *Stem* semi-erect, 15-25cm long. *Pseudobulb* present. *Leaves* 8-14cm × 5-6cm, 3-4 in number, ovate, acute with undulated margin, sheathing leaf base in lower one. *Inflorescence* terminal raceme. *Flowers* small, yellowish green in colour with purple tinge at centre, *ca.* 1.2cm × 8mm. *Sepals* sub-equal, lateral one oblong, nerved, dorsal sub-acute. *Petals* longer than sepals, 3 nerved, recurved, obtuse. *Labellum* shield like, tip 2 lobed, auricles slightly overlapping *Column* fleshy. *Pollinia* 4, elliptical.

Distribution

It is distributed throughout the sub-tropical to temperate Himalayan region at an altitudinal range of 1,700-2,100m, and also widely distributed across Nepal, Indo-China, Thailand, Burma to Philippines (Abraham and Vatsala, 1981; Deva and Naithani, 1986; Chowdhery, 1998).

Flowering

July-August

Fruiting

August-September

Biological Status

Near Threatened (NT)

Plant Part Used

Pseudobulb

Uses

Medicinal, important ingredient of Ashtavarga, used in Chyawanprash (tonic), to cure blood disorders, burning sensation in the body, male sterility, fever, dysentery, external and internal haemorrhage and general weakness. It is also used as an aphrodisiac, against insect bite, and rheumatism.

Habitat Ecology

Malaxis acuminata is a terrestrial geophyte that grows in the sub-tropical to temperate regions and it is common by found in moist, shady, and humus rich soils. It is also occasionally found on humus laden stony surfaces. It was common in the surveyed area and was observed to grow in groups of 5-15 plants on

the semi exposed forest borders and road side situations. Grasses, ferns, members of Asteraceae etc. are its common co-habitants. Amongst orchids, *Herminium lanceum* and *Liparis nervosa* were found to be associated with this species.

***Malaxis muscifera* (Lindl.) Ktze.**

Plants terrestrial, variable in size (5-30cm tall). *Pseudobulb* small, ovoid. *Stem* flexuous, green, basally covered with one or more sheath. *Roots* many, clustered at base of pseudobulb. *Leaves* 2, unequal, spreading, blade of larger leaves measuring at 2.5-10.5cm × 1.5-4cm, of smaller measured at 1-6cm × 0.5-3.5cm, elliptic to oblong or oblong-lanceolate, obtuse or acute or sub-acuminate, petiolate, petiole sheathing. *Inflorescence* raceme, 8-20cm long, scape greenish. *Flowers* small, yellowish-green. *Bracts* slightly shorter than pedicelled ovary. *Sepals* sub-equal, 2-2.3mm long, oblong-lanceolate, sub-acute. Dorsal sepal directed downwards, laterals upwards. *Petals* linear, spreading, shorter than sepals. *Labellum* fleshy, broadly ovate, 2.5mm long, with a beak, basal portion excavated, side lobes obscurely angled on either side of base, apex acuminate. *Column* minute, fleshy. *Pollinia* 4, sub-globose. *Pedicelled ovary* upto 3mm long, pedicel twisted.

Distribution

It is distributed in temperate to sub-alpine areas between 1,850-3,700 m in the Himalayan region from Pakistan to India (Jammu and Kashmir to Arunachal Pradesh) and Nepal (Deva and Naithani, 1986).

Flowering

July-August

Fruiting

August-September

Biological Status

Vulnerable (VU)

Plant Part Used

Pseudobulb

Uses

In addition to Chyavanprash, it is used as nutritive tonic, for curing bleeding diathesis, burning sensation, fever, phthisis, bronchitis, and tuberculosis. It also enhances sperm formation.

Habitat Ecology

Malaxis muscifera is a terrestrial geophyte that grows in the sub-tropical to temperate regions and usually found in moist, semi-shady forest floors, as well as on

open grassy slopes. The species is perennial and completes one phase of lifecycle in a short period of six months (mid April to end of September) and remains dormant by means of the underground pseudobulb during winter. In the next favourable growing season, plant grows either from dormant apical bud of underground pseudobulb or through seed germination. After the end of flowering and fruiting, the aerial parts dry up, and the underground parts enter into dormancy. In the study area, this species was found to grow in groups of 2-4 plants on the semi exposed grassy forest slopes. Grasses, pteridophytes namely *Selaginella* sp., *Rosa* sp. etc. were common co-habitants. Some of the tree elements in the surrounding area were *Cedrus deodara*, *Pinus wallichiana*, and *Rhododendron arboretum*. Amongst orchids, *Cephalanthera longifolia*, *Epipactis helleborine*, and *Herminium lanceum* were found to be associated with this species.

***Herminium lanceum* (Thunb. ex Sw.) Vuijk**

Plants terrestrial, 20-40cm tall. *Tuberoids* ovoid or ellipsoid, fleshy, 1-3cm x 1.5cm. *Stem* slender, 20-35cm long, with 1 or 2 sheathing scales near base. *Leaves* usually 3, rarely 2, linear-lanceolate, 10-25cm x 0.7-1cm, apex acuminate, base narrowed into sheath enclosing stem. *Inflorescence* 10-20cm long, cylindrical, dense spike, with few scales below. *Bracts* lanceolate, 5-9mm long, pedicel and ovary shorter than or nearly as long as bracts. *Flower* dense, 50 or more, green, ca. 1 cm long. *Sepals* sub-equal, ovate-oblong, 3-4mm long, 1.2-1.5mm wide, apex obtuse. The dorsal sepal and petal adhering to form a hood lateral pair spreading. *Petals* narrowly oblong or lanceolate, mainly 1-nerved, 3-4mm x 0.6-0.8mm, contracted at base; lip spreading, long rectangular, lower part undivided, 3-5mm x 1mm, base slightly saccate, obscurely auriculate laterally, ca. upper part deeply 3-lobed, mid lobe 0.5mm long, lateral lobe linear 2-5mm long, 0.5mm wide, often recurved near tip; column. 0.6-1mm long; staminodes whitish, with clavate stalk ca. 0.5mm long.

Distribution

Herminium lanceum is found at an altitude of 1,500-3,000 m throughout the North Western and North Eastern India. In India, it is distributed in the Himalayan region (Kashmir to Arunachal Pradesh), and in the entire seven sister states of North Eastern India. It is also found in Bhutan, China, Burma as well as the entire South East Asia (King and Pantling, 1998; Deva and Naithani, 1986; Singh *et al.*, 1990; Chowdhery, 1998).

Flowering

July-August

Fruiting

August-September

Biological Status

Endangered (EN)

Plant Part Used

Whole Plant

Uses

The whole plant is medicinal and is used to treat cold and fever, rheumatism, typhoid fever, hernia, sores, eczema, snake bites, and for reducing swelling and pain. The extract of the plant is also given to cure suppressed urination.

Habitat Ecology

Herminium lanceum is a geophyte with vast ecological amplitude. The species grows in the sub-tropical to temperate regions and common in humus rich soil intermixed with litter and bark. It is usually encountered under shady conditions but sometimes it is also available in open grasslands from low to high elevations. It was found to grow alone or in small groups of 2-3 plants in presently surveyed area. It shares the habitat with grasses, mosses, and other herbaceous plants. Amongst orchids, *Epipactis helleborine*, *Habenaria edgeworthii*, *Malaxis acuminata*, and *Satyrium nepalense* were found to grow in the vicinity.

***Liparis rostrata* Rchb. f.**

Plants terrestrial. *Pseudobulb* ovoid, upto 2.5cm. *Roots* numerous, arising from the base of pseudobulb in tufts. *Stem* 5-30cm long with two sheaths. *Leaves* 2, opposite, 5-16cm x 3-4cm, petiolate, membranous. *Inflorescence* laxly flowered raceme. *Flowers* 3-15, greenish yellow, flushed with purple, ca. 1.5-2cm across. *Sepals* and *petals* equal. *Sepal* 3 nerved, lanceolate or spatulate. *Petals* linear, reflexed, one veined. *Labellum* unlobed, flat, without calli, cordate, margin crenulate. *Column* with two nob-like structures at base. *Anther* beaked.

Distribution

It is distributed in the sub-tropical to temperate Himalayan region (from Pakistan to Sikkim) at an altitudinal range of 1,500-2,500 m (Abraham and Vatsala, 1981; Deva and Naithani, 1986; Chowdhery, 1998).

Flowering

July-August

Fruiting

August-September

Biological Status

Endangered (EN)

Plant Part Used

Tuber

Uses

Used for curing stomachache and malignant ulcers.

Habitat Ecology

Liparis rostrata is a terrestrial geophyte that grows in the sub-tropical to temperate regions; it is common by found in moist, shady, humus rich soil intermixed with fallen barks and leaves. This species prefers shady conditions. In the surveyed area, it was found to grow singly or in groups of 2-5 plants on partially shaded humus rich forest floors and on roadside grassy slopes. Grasses, mosses, liverworts comprise the associated vegetation. Amongst orchids, *Epipactis helleborine*, *Habenaria edgeworthii*, *H. intermedia*, *Malaxis acuminata*, and *Satyrium nepalense* were found to be its co-habitants.

Discussion

Globally, orchids are the most threatened species amongst the flowering plants. Infact, these are highly specialized and require specific habitats and circumstances for their growth and development. As orchids are more vulnerable to habitat loss and environmental degradation, these state the fitness of a given ecosystem and are considered as the indicator plants. Further, these species are depleting at an alarming rate due to over exploitation, habitat destruction by urbanization and shifting cultivation, loss of pollinators, destructive diseases, climate changes and unauthorized trade (Kumar *et al.*, 2016; Kumar *et al.*, 2017; Pant *et al.*, 2007; Prakash *et al.*, 2018). The loss of biodiversity is a major threat for the scientific community to think about the conservation of these species in the natural habitats (Jalal *et al.*, 2009). The species like *Habenaria intermedia* and *Malaxis muscifera* have been exploited at such a level, that they have been considered as endangered species (Chauhan *et al.*, 2007, 2008). Similarly the other 2 species, *Malaxis acuminata* and *Habenaria edgeworthii* are also facing the survival threats. Thus, there is an urgent need to take every possible measure to conserve the gradually declining natural population of these valuable plants both by *in situ* and *ex situ* means as

has also been suggested earlier by Kant *et al.* (2012). One of the main causes for the depletion of orchid biodiversity is the lack of any true awareness or appreciation of its value. Another reason is the lack of financial resources and current investment levels by the government remain inadequate. In addition to increasing such funding, the government should encourage the active participation of all sectors of society in biodiversity conservation, particularly the private sector, and non-governmental organizations. Environmental education should also be strengthened and specifically geared towards indigenous and local communities.

The State of Himachal Pradesh supports relatively very less number of orchids compared to Western, Central, and Eastern Himalaya (Deva and Naithani, 1986; Devi *et al.*, 2018; Samant, 2002) and comprises of about 84 species of orchids (Jalal and Jayanthi, 2015). These orchids are widely used in traditional system of medicines. Different plant parts such as leaves, tubers, aerial parts, rhizomes, bulbs, roots, and stems have been used by the local inhabitants for various therapeutic uses. But it is sad that necessary scientific studies on the medicinal properties of these orchids are still on the bottom of the agenda. Thus, extensive research is necessary to be able to fully recommend the orchid species for their medicinal uses. Also, the rich natural gene pool of orchids is depleting at an alarming rate particularly due to over-exploitation for medicinal and ornamental purposes. Regular monitoring of the species in relation to climate change for understanding the dynamics and creating awareness among the local inhabitants and forest officials, and conservation through *in vitro* propagation are suggested. Though some attempts have been made for conservation of orchids of Himachal Pradesh by developing efficient *in vitro* mass propagation protocols (Bhattacharjee and Hossain, 2015; Bhatti *et al.*, 2017; Borah *et al.*, 2015; Chauhan *et al.*, 2015; Decruse and Gangaprasad, 2018; Kaur *et al.*, 2017; Pathak *et al.*, 1992, 2011), much is still to be learnt about the nutritional requirements of these orchids. Recent advances in conservation biology with biotechnological approaches have paved the safeguard for plant biodiversity, however, very little effort has been made to cultivate the medicinal orchids for commercial scale, which have put further stress. Thus, besides promoting artificial propagation, collection of any orchids from wild should be totally banned at every level and awareness should be created for effective conservation.

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