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Satyrium nepalense D. Don.: A Multi-Faceted Threatened Medicinal Orchid

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ABSTRACT

Orchids have long been prized for both their attractive flowers and their medicinal qualities. *Satyrium nepalense* D. Don. is a terrestrial Orchid characterizing it as the sole species having two varieties: *Satyrium nepalense* var. ciliatum with pink blooms and *Satyrium nepalense* var. nepalense with white flowers. This orchid is exceptional since it is one of the few whose range includes both the Himalayas and the Western Ghats. It is one of the multi-purpose orchids with therapeutic, nutritional, and aesthetic benefits as well as aroma. Its extensive elemental composition, which contains triterpenes, alkaloids, flavonoids, and unsaturated sterols, makes it eligible to be classified as a medicinal orchid. The juice of the plant is used to treat fever as well as cuts and wounds, and the dried tubers are used as a dysentery preventative. The survival is threatened by natural factors including habitat loss triggered by undulating topography and landslides sparked by heavy rains. Projects involving anthropogenic development have fragmented and damaged habitats while displacing species. Due to overgrazing and the collecting of it for fodder in regions where people are unaware of its importance, its viability is periodically questioned. Its multiplication by conventional and micropropagation methods, as well as its restoration into natural habitats and niche regions, will be a significant conservation effort.

Keywords Medicinal orchid, Ethnobotany, IUCN, Conservation, Micropropagation.

INTRODUCTION

Orchids have long been valued for their curative properties as well as their beautiful blossoms. Despite advances in our understanding of the orchid family, the orchid extinction risks are increasing daily. Epiphytes, terrestrials, and semi- or fully parasites are the three primary life forms of orchids. With roughly 1,000 genera and 25,000-35,000 species, orchids are the most developed monocotyledon family. Their flowers come in a wide range of sizes, shapes, and colors. Orchidoideae, Epidendroideae, Cypripediodeae, Vandoideae, Aspostariodeae, and Spiranthoideae are the five subfamilies of the Orchidoideae family(Cetzal and Savelli 2014). It is India's second largest

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angiosperm family, behind Poaceae, with roughly 1258 taxa divided into 178 genera. They also inhabit a diverse range of habitats, from tropical to alpine, with about 35000 species and 800 genera worldwide. The Himalayas are the major habitat for over 1,600 orchid species, accounting for nearly 10% of the world's orchid flora (Bhanwra *et al.* 2006).

The medicinal benefits of orchids have long been recognized, in addition to their exquisite blossoms. Despite improvements in our knowledge of the orchid family, the threats to its survival are getting worse every day. 948 (3.3%) of the world's orchid species have been classified as endangered on the IUCN Red List of Threatened Species (Handa 1986, Govaerts *et al.* 2017). Discovering the biology, evolution, taxonomy, cytology, chemistry, hybridization, and culture among other aspects of the family is receiving a lot of attention worldwide.

Satyrium nepalense D. Don. is a terrestrial Orchid characterizing it as the sole species having two varieties: *Satyrium nepalense* var. ciliatum with pink blooms and *Satyrium nepalense* var. nepalense with white flowers. It is one of the multi-utility orchids having medicinal value, dietary supplement, and ornamental value having fragrance (Sahoo and Ansari 2007, Yonzone and Rai 2017, Pamarthi *et al.* 2019).

The Genus Satyrium: Distribution, status, and habitat

The genus name Satyrium comes from the Greek word Satyrion (satyr). The Satyri of Greek mythology were sylvan demi gods known for their lewdness and for making references to the alleged aphrodisiac powers of plant tubers (Sahoo and Ansari 2007, Yonzone and Rai 2017). This genus of terrestrial orchids, which includes about 92 species, is almost entirely restricted to continental Africa, with just five species found in Madagascar and four species in Asia. The genus's origin is unknown, but a recent molecular phylogenetic analysis revealed that it differentiates into two major radiations in the fynbos shrublands of the southwest Cape and the grasslands of southern and central Africa, which account for around 55 of the current species (Niet *et al.* 2005, Van der Niet and Linder 2008). The Satyrium genus (Orchidaceae, Diseae) exhibits a high degree of floral variation and broad proliferation of pollination systems (Vogel 1954).

Its presence in alpine meadows and temperate forest borders at elevations of 1200- 4500 m with a habitat of Alpine Pinus forest and grassy slopes has been reported in Bhutan, China, India, and Nepal on the Asian subcontinent (Wu *et al.* 2013, Chen *et al.* 2009, Raskoti 2009, Pierce and Cribb 2002). This species prefers open meadows; fewer individuals have been spotted in shaded locations or under tree canopies. Along the elevation gradients at the research location, there were no frequency, density, or abundance changes. *S. nepalense* D. Don., sometimes known as Nepal Satyrium, is found in the Indian Himalayan Region from Shimla eastward, the Khasia Mountains, and the Deccan Peninsula surrounding Travancore generally between 1800-2300 m. It is a remarkable orchid since it is one of the few with a distribution that spans both the Himalayas and the Western Ghats (Tarun Chhabra 2000, Nageswara Rao 2004, Mahendran and Bai 2008, Mishra *et al*. 2018, Babbar and Singh 2016).

For it to grow and proliferate, a specialized microhabitat is required (Paudel and Poudel 2019). These plants, which need acidic soil, are frequently encountered in nearly gregarious environments. We have sometimes observed Satyrium var ciliatum growing in lithophytic habitat, although it is uncommon for var ciliatum and var nepalense to coexist in the same setting (Yonzone and Rai 2017).

According to research by Yonzone and Rai in (2017) the var. ciliatum is more common and the var. nepalense is rare in the Darjeeling Himalayas. Sahoo and Ansari (2007) made a similar report on *S. nepalense* D. Don., during their exploration in the Sikkim region with Satyrium nepalense var. nepalense with pink flowers and *Satyrium nepalense* var ciliatum with white flowers. Based on habitat and blossom color, they have reported ciliatum as nepalense and vice versa, which conflicts with the majority of the scant research on this medicinal orchid. It's possible that a typographical error or misidentification caused this problem.

Photoplates: Exploration conducted during 2018-2019 under NMPB Project

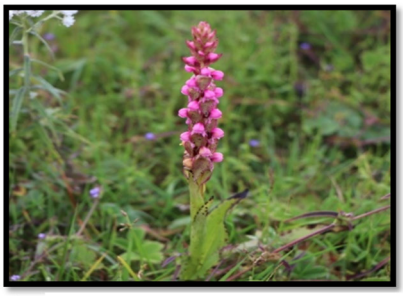

Fig.1

Fig.2

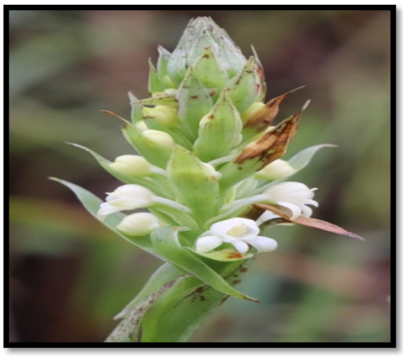

Fig.3

Fig.4

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Fig.6

Fig. 1. *Satyrium nepalense* var. *ciliatum* with pink blooms. **Fig. 2.**. *S. nepalense* var. *ciliatum* in natural habitat (Tigerhills, Darjeeling) **Fig. 3.** *S. nepalense* var. nepalense with white flowers **Fig. 4.**. *Satyrium nepalense* D. Don in vegetative stage **Fig. 5.** Dried *S. nepalense* D. Don. with tuber. **Fig. 6.** *S. nepalense* D. Don. seed for *In-vitro* germination.

Morphological features

The description of the species and their qualitative morphological features are briefly consolidated in Tables 1-2. Photo plates 1-6 depict their identification and collection for preservation at a field gene bank as well as the standardization of tissue culture procedures and the initiative for conservation and commercialization funded by the NMPB. Satyrium flowers, which have a labellum with two spurs, are rather unusual among orchids (Garside 1922, Vogel 1954, Johnson 1997) developed the fundamental functional morphology of Satyrium flowers.

Its flowers are very significant in terms of pollination because of their peculiar form and characteristics

Table 1. Classification of *Satyrium nepalense* D. Don.

Kingdom	Plantae
Division :	Magnoliophyta
Class :	Liliopsida
Order :	Asparagales
Family :	Orchidaceae
Subfamily :	Epidendroideae
Tribe :	Coelogyneae
SubTribe :	Coelogyninae
Genus :	*Satyrium*
Species :	*Satyrium nepalense* D. Don.
Altitudinal range :	1200-4500 m
Flowering and fruiting :	October-December
Present availability status :	Threatened species

like twins purred labellum(Vogel 1954, Dressler 1993, Kurzwel 1995). The vast floral diversity of Satyrium was originally documented by Vogel in (1954). He understood how flowers function and predicted that *S. bracteatum* would display myiophily. It is unusual for one species of orchid to have evolved so many different pollination techniques (Dodson and Van Der 1966). The Todas, who are the original inhabitants of the higher Nilgiris, gave the blossoms the name Ezhtkwehhdr because their twin spurs resembled bullock horns (Chhabra 2000).

These plants ranged in height from 15 to 37 cm and featured an oval tuber. Their leaves were sheathed and had an acute, oblong-lanceolate base. The only thing that distinguished the flowers from one another was their color. Satyrium var. ciliatum was pinkish, unlike Satyrium var. nepalense. which was found to be white. The description of the species and their qualitative morphological features are briefly described in Tables 1-2.

Ethnobotany and medicinal importance

The Todas of Nilgiris utilizes the dried, powdered tubers of this terrestrial orchid as an energizing tonic. To treat malaria and diarrhea, the Mopa tribe eats the entire plant including its roots (Rao 2004, Mahendran and Bai 2008).

In Nepal, the tubers of *S. nepalense* D. Don. are used as a tonic to treat malaria, diarrhea, and dysentery (Baral and Kurmi 2006, Pant and Raskoti 2013).

Table 2. Morphological features of *Satyrium nepalense* D. Don. (Bussmann 2021).

Parameter/ Feature plant part	Features
Habitat :	Epiphytic sometimes terrestrial
Height	20–70 cm tall
Stem	1–3 membranous sheaths at base, 1- to 3-leaved
Tubers	oblong-ellipsoid to ellipsoid, 2–5× 0.5–1.5 cm
Root	Adventitious arising from base of rhizome (fibrous)
Leaves	basal and subopposite, or sometimes cauline and widely spaced and alternate, broadly ovate, ovate-lanceolate, or lanceolate-oblong, slightly fleshy, margin somewhat crisped, apex acute or acuminate
Flower	fragrant, widely spreading, whitish, pink, or pale purple, glabrous, hermaphroditic or with reduced stamen and functionally female
Calyx	Dorsal sepal narrowly oblong-elliptic, 4–6 x 1–1.8 mm, apex obtuse; lateral sepals oblong to subovate, slightly oblique, 4–6 x 1.5–2 mm, apex obtuse.
Corolla	narrowly oblong to narrowly elliptic, 3.5–5 x 1–1.2 mm, outer surface carinate, margin sometimes finely ciliate, apex acute to obtuse and sometimes incised; lip hooded, subglobose, 5–6 x 4–6 mm, outer surface carinate, 2-spurred, margin sometimes irregularly dentate, apex acute or obtuse and often deflexed; spurs parallel, slender and cylindric, to stout and conic, curving downward, 3–13 mm, or reduced and saclike, or rarely absent altogether
Fruit	Capsule , spindle shaped
Seed	Microscopic, powdery

Similarly, its dried tubers are used as a deterrent against dysentery, and the juice is used to cure fever as well as cuts and wounds (Subedi *et al*. 2013, Medhi and Chakrabarti 2009, Joshi *et al.* 2009, Mishra and Dutta 2003, Kumari *et al.* 2009, Lawler 1984, Vij 1996, Rao and Sridhar 2007).

In Arunachal Pradesh the Monpa tribe (Northeastern India) and Tibet (China), also utilize tubers as an aphrodisiac and to treat malaria and diarrhea. The stem of this plant is used to nourish the blood, support the kidneys, reinforce the loins, and calm the mind (Geck 2011, Teoh 2016). Local tribes in Uttarakhand in the Western Himalayas and tribal people in the Kudremukh National Park in Karnataka (Southwestern India) utilize the tubers of *S. nepalense* D. Don. along with the tubers of other orchids to cure malaria and diarrhea (Rao 2007, Jalal *et al.* 2008). *Satyrium* species are used as edibles and are essential to human

sustenance in the Nagaland region (Deb 2013).

Nutritional and phytochemical composition

Since the ancient period, *Satyrium* sp. has been used in ethnomedicinal research. However, there has been a successful screening for phytochemicals that are effective for medicinal purposes during the past decade. In addition to other medicinal orchids, more research and germplasm collection with high concentrations of therapeutic chemicals must be done, according to (Wei *et al.* 2021), for use in future artificial production. The identification and characterization of chemicals may lead to novel therapeutic possibilities for experimental disorders because an adequate phytochemical study of plants has not yet been conducted Bhatnagar *et al*. (2017).

One of the first phytochemical assessments of this orchid was carried out by Saklani *et al.* (2011) and Mishra *et al.* (2012). Both of them claim that methanolic extract has excellent antibacterial activity against ten types of food-borne pathogens, including *Bacillus cereus, Escherichia coli, Enterobacter gergoviae, Klebsiella pneumonia, Salmonella entericatyphim, Shigella flexneri, Staphylococcus aureus, Staphylococcus epidermidis,* and *Streptococcus pyogenes*. It qualifies as a medicinal orchid because of its considerable chemical composition, which includes triterpenes, alkaloids, flavonoids, and unsaturated sterols.

Quercetin, an essential bioflavonoid having anti-inflammatory, antioxidant, antihistamine, anti-edematous, anticancer, and direct radical scavenging activities, was found to be present in the tubers of *S. nepalense* D. Don. in Mishra *et al.* (2014). In addition, they created an HPTLC technique for the identification and measurement of quercetin in the methanol extract of the tubers of this therapeutic orchid.

Bhatnagar *et al.* (2017) first reported *S. nepalense*. as having leishmanicidal and antimycobacterial properties. They examined the leishmanicidal potential of promastigotes and amastigotes of *Leishmania donovani,* the antimycobacterial activity of Mycobacterium TB (H37Rv and MDR strain), and the antibacterial potential of two gram-positive and three gram-negative clinical isolates. They concluded from their investigation that *S. nepalense* was the most promising plant because it carried significant amounts of all three functions.

The presence of phenolic acids and flavonoids, specifically gallic acid and quercetin, maybe the reason why methanol extract had the most secondary metabolites and the highest antioxidant and antibacterial activities in comparison to the other extracts, according to qualitative phytochemical screening and biological activity evaluation. This was confirmed by Mishra *et al*. in (2018) by LC-MS/MS study.

Threat perceptions and conservation measures

Since we only have a limited understanding of the wild orchid populations, we require thorough investigation to set priorities for the preservation of their environment and preventing their extinction in the future. All wild orchid populations are potentially endangered by anthropogenic development and natural variables.

Natural variables include habitat loss spurred on by undulating topography and landslides brought on by high rainfall are dangers to the survival of *S. nepalense* D. Don. The phenology of this species, from growth to reproduction, has been impacted by the shift in the local weather pattern, which also hurts the number of pollinators. The native flora is seriously threatened by the invading species' rapid expansion and adaptation.

Roads, dams, buildings, and other anthropogenic development projects have displaced species, causing habitat damage and fragmentation. Because of the therapeutic benefits of this species and the great demand from pharmaceutical corporations, merciless harvesting from its habitat has resulted in a decline in the species' natural population. Its viability is occasionally questioned as a result of overgrazing and the gathering of it as fodder in areas where people are ignorant of its significance.

Conservation is "the maintenance of essential ecological processes and life-support systems, the preservation of genetic diversity, and the sustainable

utilization of species and ecosystems" (Talbot 1980). Until and unless we go for a holistic system for the conservation of this species, the threats factors considered above will surely deplete it the medicinal orchid in a study nature leading to its extinction. To conserve this species we need to consider *In-situ, Ex-situ,* Capacity building, and other measures amenable to the site of its availability.

The best *In-situ* measures of conservation applicable for preserving the genetic diversity of this species is through identifying Orchid Conservation Areas (OCAs) which must be prioritized to protect them in their wild habitat. The concept of community conservation through promoting concepts of sacred groves and forests like in areas in North-East India must be emphasized. (Medhi and Chakrabati 2009, Jalal 2012).

The *In-vitro* germination of seeds is the most efficient method of regenerating native terrestrial orchids for conservation initiatives. A dependable method for doing so that uses immature seeds in a symbiotic culture must be prioritized as one of the key measures of *Ex-situ* conservation. (Mahendran and Bai 2008). Conservation and propagation of field and seed gene banks and developing botanic gardens, research facilities, and forest nurseries where a population and genetic variety of such endangered orchids may be preserved under expert supervision. Growing them and replanting them in their original environment can further increase this species' chances of survival.

We have been conducting explorations and establishing an *In-vitro* protocol for standardization and rapid regeneration of tissue culture for medicinal orchids at the Regional Research Station, Hill Zone, Uttar Banga Krishi Visvavidyalaya (Data not published) and Field gene bank conservation strategy as part of the NMPB-sponsored project (Fig. 1-6). This is an important step toward the species' conservation for multiplication of those plants employing tissue culture techniques and conventional strategies for their replanting in natural habitats and niche regions. Also educating people about good collection practices (GCP), which allow for the removal of a small number of plants or their propagules from their natural habitat without compromising those plants' ability to survive and regenerate in the future.

Since people in many areas of *S. nepalense's* D. Don. natural habitat are still uninformed of its therapeutic potential, they just ignore this plant as a common grass and never make an effort to protect it. To prevent *S. nepalense* D. Don. from vanishing from its natural habitats, emphasis must be placed on educating villagers about the medicinal properties of this plant species. For the long-term protection of this plant species, extensive study embracing many ecological aspects is required, including habitat assessment, phenology, and reproductive biology (Paudel and Poudel 2019).

The efforts needed to preserve these medicinal orchids in the region where they are found by implementing a widespread grassroots education program in the region in partnership with Gram panchayats, schools, and colleges, forest departments, wildlife personnel, and NGOs that may help keep these species in their natural habitat. The encouragement toward the use of traditional methods to conserve endangered plant species, and encourage the creation of plans for the sustainable commercialization of traditional goods. We must also put efforts into initiatives for ecotourism in a sustainable community-based form (Geck 2011).

CONCLUSION

To summarise, *S. nepalense* D. Don. a threatened medicinal orchid, has been used in ethnomedical studies to cure malaria, diarrhea, and dysentery since ancient times. Because of its varied chemical makeup, which contains triterpenes, alkaloids, flavonoids, and unsaturated sterols, it is recognized as an orchid with therapeutic benefits. A significant conservation effort will be the proliferation of *S. nepalense* D. Don. using micropropagation methods and conventional methods, as well as its restoration into natural habitats and niche regions. To prevent their extinction and over-exploitation, promoting their large-scale production through their cultivation would improve both primary and secondary health care while also boosting sustainable rural living.

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