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DIVERSITY AND DISTRIBUTION OF GENUS *HABENARIA* WILLD. (ORCHIDACEAE) IN SHIMOGA DISTRICT, KARNATAKA, INDIA

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Abstract

The present paper deals with the study of genus *Habenaria* (Orchidaceae) in Shimoga district of Karnataka and reports its 12 species in the region. The research was carried out from the period of January 2018-January 2021; the distribution, phenology aspects, and biological status of the species was assessed in the district. Extensive field surveys were carried out periodically in different parts of the district, including hilly region, and grasslands for the purpose. *Habenaria* species was found to be abundant in grasslands and hilly regions, as compared with other forest types in Shimoga district. Changes in the rainfall pattern and anthropogenic activities highly affect the diversity of the plants.

Introduction

ORCHIDACEAE IS a monocot family that includes terrestrial, saprophytic, lithophytic, and epiphytic species (Arditti, 1977; Pridgeon *et al*., 1999). It is one of the largest families amongst monocots and the second largest flowering plant family with 28,484 species in 800 genera (Govaerts *et al.,* 2017). Abraham and Vatsala (1981) recorded 150 species under 70 genera from South India. The recent estimate suggests the occurrence of as many as 320 orchid species in South India (Bhat, 1999); of these, 176 species are reported from Karnataka (Krishnaswamy *et al.,* 2004a; Udupa *et al*., 2011). The most interesting feature of the orchid flowers is their striking resemblance to various forms of the animals like a bee, moth, butterfly, spider, dove, even humans *etc.* (Pal *et al.,* 2019; Prakash and Pathak, 2020a). They are floriculturally significant due to the varied colour and range of sizes and shapes of their flowers (De and Pathak, 2020; Janakiram and Baskaran, 2018; Prakash and Pathak, 2020b).

Orchids are associated with an endophytic symbiotic fungus, mainly in their roots (Manoharachary, 2019). Terrestrial orchids mainly grow on the floor of the forest and grasslands.

Habenaria Willd. is a terrestrial orchid genus of about 800 species, widely distributed throughout the tropical, subtropical, and temperate regions of the world. Amongst these, 60 species are reported from India. About 25 species of *Habenaria* are found in Peninsular India. In Karnataka, 26 species of *Habenaria* were observed (Krishnaswamy *et al.,* 2004b). In India, it is represented by 17 species in Western Himalaya (Jalal and Jayanthi, 2015) and some of these are well known for their therapeutic properties (Balkrishna *et al.,* 2020; Chauhan, 1990; Devi *et al.,* 2018; Kumar *et al.,* 2018; Kumar *et al.,* 2019; Kumari and Pathak, 2020; Prakash and Pathak, 2019; Vij *et al*., 2013). In *Habenaria,* prominently paired tuberoids with a small third tuberoid is also seen (Pande *et al.,* 2010). In *Habenaria* species, flowers are highly attractive. The species can be easily identified when in bloom, but the vegetative characteristics (number and size of tubers and leaves, stem height) overlap in many of these. Terrestrial orchid diversity remains largely understudied. Therefore, during the present investigation, diversity and distribution of genus *Habenaria* Willd. in Shimoga District, Karnataka, India was studied.

Material and Methods

Study Area

Shimoga district is a part of Malnad region of Karnataka and is also known as the *Gateway to Malnad*. There are seven talukas namely Soraba, Sagara, Hosanagara, Shimoga, Shikaripura, Thirthalli, and Bhadravathi (Fig. 1); the district is situated between the latitudes 13°27' and 14°39' N and between the longitudes 74°38' and 76° 04' at a mean altitude of 640 m amsl. Peak Kodachadri hill at an altitude of 1343 m amsl is the highest point in the district. Shimoga district is rich in diversity of flora and fauna. The District covers evergreen, semi-evergreen, deciduous, scrub forest, and grasslands.

Data Collection

The survey was undertaken in Shimoga district during the year January 2018-January 2021. Different types of vegetation were found (evergreen forest, deciduous

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forest, scrub forest, plantations areas, and grasslands). Frequent field visits were carried out in all the seven taluka of the district. Random field survey sampling method was used for collection of *Habenaria* species. Phenology of *Habenaria* species in Shimoga district was studied. The specimens were collected and identified with the help of available manuals, floras, and research papers (Choudhary *et al.,* 2011; Gamble, 1935; Rao, 1998). Important aspects were recorded and photographs were taken during field surveys. Herbaria were prepared as described by Rao and Sharma (1990) and the specimens were deposited in the herbarium, Department of Botany, Sahyadri Science College, Shimoga, Karnataka, India.

Results and Discussion

The floristic assessment of *Habenaria* in different regions of the study area revealed a total of 12 species. A detailed checklist of species, habitat, morphology, and phenology of the all the species and photographs of the species are provided (Tables 1-2; Fig. 2A-L).

Morphology

Habenaria longicorniculata J.Graham.

Terrestrial herb, grows up to 10-20 cm height. *Leaves* oblong to elliptic, 3-10 clustered on the base, and present as flat on the ground. The *flowers* produced on a long erect stalk measures up to 80 cm tall. *Flowers* 1 to 4 in number, usually two flowers seen and these were white and fragrant in nature. Flower had the shape of an inverted funnel. Flowers usually seen in grasslands and rocky slope. Flowers mainly bloom in the month of August to September. This species has one of the largest *spur* in the plants commonly seen in the Western Ghats. The *sepal* has a green colour, the lower *labellum* is pure white. The plant stays in dormant condition and survives on its underground *tubers*. The plant multiplies both vegetatively and also through the seed dispersal from the pollinated flowers. Habitat destruction and grazing are the main threats to these plants (Fig. 2C).

Fig. 1. Study area- Shimoga district in Karnataka state, India.

H. elwesii Hook.f.

This terrestrial species bloom in the month of September to October. The plant grows up to 13-15 inches height. The *inflorescence* produces 5-6 flowers. The *labellum* is 3 lobed and *petals* have two lobes, in which one of the lobe is covered with soft tuft hair. The *flowers* are greenish-white in colour and about 1-2 cm wide. This species is mainly present in grassy slopes on the edges of the forest. Leaves are 3-5 in number. The plant survives on its underground *tubers* and produces new shoots in monsoon (Fig. 2F).

H. heyneana Lindl.

This terrestrial orchid is called as *toothbrush orchid*. It is mainly found in high altitude hilly region. The plant grows up to 10-20 cm height, produces *flowers* in the month of August to October. White medium-sized flowers are present on a long flowering axis. The plant bearing 5-6 *leaves* produces 10-15 flowers on flower stalk. The plant survives on its underground *tubers*, till the upcoming monsoon season (Fig. 2E).

H. grandifloriformis Blatt. & McCann

This terrestrial orchid is called as large-flowered *Habenaria* or single-leaved *Habenaria.* It is endemic to the Western Ghats; plants are mainly present in elevations around 1000 m and plants are lithophyte with prominent *tubers*. Basal flat ground hugging single *leaf* is present. The plant produces 1 to 4 pure white *flowers*. *Petals* are bilobed, lip with 3 narrow lobes. *Spur* is longer than the ovary, flower produced during June-July. It is one of the first flowering herbs to appear at the starting of monsoons (Fig. 2G).

H. crinifera Lindl.

This terrestrial orchid is commonly known as doll orchid, mainly found in the evergreen forest. Plants bloom as whole group at late rainy season. These are tuberous orchids, grow in both epiphytic and terrestrial forms. *Leaves* are 2-6 basally clustered, oblong to lanceolate, tapering towards the base. Plants bloom in the month of August to October. *Flowers* are 2-8, white coloured; compared with the *sepals,* long claw is present, the outer margin is toothed. *Spur* is slender and incurved. *Flowers* are highly showy in nature (Fig. 2I).

Habenaria plantaginea Lindl.

This terrestrial orchid is common in Shimoga district and was observed in forest openings. The plant attains a height of about 10-25 cm. Ground hugging *leaves* are present, the number varies from 5-6, *flowers* are glabrous white with lanceolate bracts, *dorsal sepal* is erect, 3 nerved, *lateral sepal* thick with 4 nerved, lip tri-lobed, long-spurred. *Tubers* are oblong in shape, helps to survive plant in a dormant condition. *Inflorescence* includes 10 to 20 flowers (Fig. 2K).

H. ovalifolia Wight

This terrestrial orchid is known as oval leaved *Habenaria.* It is endemic to NorthWestern Ghats. In this plant, *dorsal sepal* is attached to produces a hood-like structure, *flower* is small, pale green in colour, produced up to 10-20 in number. *Leaves* are oval-

Fig. 2. A-L. A, *Habenaria pelorioides* (*Odisha cleistantha*); B, *H. marginata*; C, *H. longicorniculata*; D, *H. ovalifolia*; E, *H. heyneana*; F, *H. elwesii*; G, *H. grandifloriformis*; H, *H. diphylla*; I, *H. crinifera*; J, *H. multicaudata*; K, *H. plantaginea*; L, *H. dentata.*

shaped, clustered on the *stem*. Flowering during July-October, the plant is seen in a thick evergreen forest. Midlobe of *lip* arched upwards and attached to dorsal sepal is the key character for the identification of the *Habenaria* species (Fig. 2D).

Habenaria marginata Colebr.

In this terrestrial orchid, presence of yellow to bright yellow coloured *flowers* are key characters for the identification of this *Habenaria* species. The plant grows up to the height of 20-30 cm. *Leaves* are flat on the ground. The *flowers* are green to yellow medium-sized flowers. *Petals* are unlobed. The plant has long *spur*, swollen at the end, lip usually three-lobed. The plant was observed in grasslands and thick forest region (Fig. 2B).

H. multicaudata Sedgw.

This terrestrial orchid is endemic to peninsular India (Kottaimuthu *et al.,* 2018). The plant is mainly present in the evergreen forest with thick vegetation. The plant grows up to 13-25 cm in height. *Leaves* simple, alternate, 5-10 *flowers* are present. They are bracteate, pedicillate, greenish-white in colour, *spur* is long, *lip* greenish-brown, flowering during August-October. *Inflorescence* axis has 10-15 flowers. The plant has large tuber. The IUCN (1996) and IUCN (2000) assessed *Habenaria multicaudata* as a vulnerable orchid species of Western Ghats (Kumar *et al*., 2001) (Fig. 2J).

H. diphylla Dalzell

This is a two-leaved *Habenaria.* Plant grows up to 8-25 cm in height. Two *leaves* are unequal in size and broadly ovate to obtuse in shape. Flower axis is 10-20 cm in length with 5-10 *flowers.* The plants were found growing mainly in the grasslands. Raceme type of *inflorescence* is observed. Flowering occurs during July-September and fruiting observed in August-September month (Fig. 2H).

H. dentata (Sw.) Schltr.

It is a medium sized *Habenaria.* The plants grow up to 40-80 cm in height, *tubers* are smooth and produce single plant. Lower part of the plant *stem* is sheathed, *leaves* are 5-7 in number, long to elliptic, *flowers* are white, more than 10 flowers are present, flowering during August-September. Plants were found growing in evergreen forests (Fig. 2L).

H. pelorioides C.S.P. Parish & Rchb.f. (*Odisha cleistantha* S. Misra)

This is a special type of terrestrial orchid in which *perianth* of the *flower* never opens. This plant is observed in only one taluk of the district. The plant was present in evergreen forest, deciduous forest and also in plantation areas; it grows up to the height of 10-30 cm. The plant has large *tuber*, produces long, slender *stem* with 5 to 8 alternative *leaves* with sheathing leaf base.

Table 1. Distribution of *Habenaria* Willd in different taluks of Shimoga district.

Species	Distribution in Taluks of Shimoga district						
	Shimoga	Soraba	Shikaripura	Thirtahalli	Sagara	Bhadravati	Hosanagara
Habenaria longicorniculata J.Graham.	+	+	+	+	+	+	+
H. elwesii Hook.f	+	+	+	+	+	_	+
H. heyneana Lindl.	+	_	_	+	+	_	+
H. grandifloriformis Blatt. & McCann	+	+	_	+	+	_	+
H. crinifera Lindl.	+	+	_	_	_	_	_
H. plantaginea Lindl.	+	+	+	+	+	+	+
H. ovalifolia Wight.	_	_	_	_	+	_	+
H. marginata Colebr.	+	_	_	_	+	_	+
H. multicaudata Sedgw.	+	_	_	+	+	_	+
H. pelorioides C.S.P. Parish & Rchb.f. (*Odisha cleistantha* S. Mishra)	_	_	_	_	+	_	_
H. diphylla Dalzell	+	_	_	+	+	_	+
H. dentata (Sw.) Schltr.	_	_	+	+	_	_	+

+, Present; -, Absent.

Table 2. Phenology of *Habenaria* species in Shimoga district.

Species	Vegetation type	Flowering period	Fruiting period
Habenaria longicorniculata J.Graham.	Evergreen, semi-evergreen, grasslands	August-October	October-November
H. elwesii Hook.f	semi-evergreen forest, grasslands, forest edges	July-October	October-November
H. heyneana Lindl.	Hills, evergreen to semi-evergreen forest.	August-October	October-November
H. grandifloriformis Blatt. & McCann	Rock hills, deciduous forest	June-August	August-September
H. crinifera Lindl.	Grasslands, evergreen to semi-evergreen forest, rock hills	July-September	October-November
H. plantaginea Lindl.	Semi-evergreen, deciduous forest scrub forest	July-September	October-November
H. ovalifolia Wight.	Semi-evergreen, scrub forest	August-October	September-November
H. marginata Colebr.	Semi-evergreen deciduous, scrub forest	August-October	September-November
H. multicaudata Sedgw.	Evergreen forest	July-September	September-November
H. pelorioides C.S.P. Parish & Rchb.f. (*Odisha cleistantha* S. Misra)	Evergreen to semi-evergreen forest	September-December	November-December
H. diphylla Dalzell	Evergreen to semi-evergreen, deciduous forest	August-September	September-October
H. dentata (Sw.) Schltr.	Evergreen to semi-evergreen forest	August-September	September-October

Inflorescence axis is long with unopened 10-15 flowers. *Flowers* are green, sepals and petals erect. *Lip* is enclosed by lateral sepal, pollinia are two, plant produces flowers in the month of October to November and fruiting observed in December (Fig. 2A).

The present study revealed that *Habenaria* Willd is the largest terrestrial orchid diversity in Shimoga district. In India, the genus is widely distributed throughout the country (Fernado and Ormerod, 2008; Jayaweera, 1981; Stewart, 1972). Field survey was carried from the year January 2019-January 2021, a total of 12 *Habenaria* species were observed and the phenology of the terrestrial orchid species was studied. The genus *Habenaria* is the largest terrestrial orchid species in the world. The majority of the species of this genus has been recorded in India at an altitude between 1000 m to 2000 m. Some species have been noted above 3900 m (Chaudhary *et al.,* 2011). Amongst 12 species at Shimoga district (Karnataka), most of the species were observed in evergreen, deciduous forest, grasslands, and least in scrub forest and dry region.

The distribution of *Habenaria* in different taluks of Shimoga district shows that the availability of *Habenaria* species is rich in Shimoga (Kodachadri Hills), Sagara (Sharavati river valley region), Hosanagara, and Theertahalli taluks. Least availability was observed in Soraba, Shikaripura and Bhadravati taluks (Table 1). All available species are very rich in Kodachadri hills and Sharavathi river valley region. *Habenaria crinifera*, *H. heyneana, H. longicorniculata* are very abundant in Kodacahadri hills. Part of the Soraba and Shikaripura, Bhadravati taluk is covered with dry deciduous and scrub forest, the terrestrial orchid is observed only in starting month of monsoon in these taluks. *Habenaria pelorioides* (*Odisha cleistantha*) was observed only in Sagara taluk. Shimoga, Sagara, Theertahalli, Hosanagara, part of Soraba taluks covers evergreen and semi-evergreen forest and grasslands. *Habenaria* species mainly prefer cool and shady area for their growth. In the case of *Habenaria* species, change in rainfall seems to play a major role in flowering and plant growth. Most of the *Habenaria* species starts to produce leaves at onset of monsoon, and ends fruiting with the onset of winter. *Habenaria grandifloriformis* was the first blooming *Habenaria* in the season and *H. pelorioides* (*Odisha cleistantha*) was the last blooming *Habenaria* species in the season, the plant sets fruits usually during September-November (Table 2).

Shimoga district with rich forest area, grass diversity, moist area, hills, dry and open areas represents the common habitat in the study area. We documented 26%

Habenaria species from grassland, 19% from forest area, 18% from hills region, 14% from moist shady area, 8% from tree shade area, 3% from scrub forest, 2% from road cuttings, and 1% from dry area (Fig. 3). Grassland, hills region, moist shady area, and forest area were observed as most suitable habitats for *Habenaria* species in the study area.

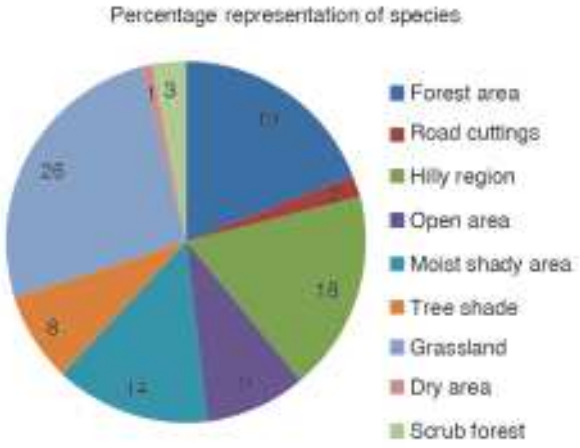

Fig. 3. Habitat distribution of documented species.

The present study revealed that *Habenaria* Willd. is the largest terrestrial genus amongst the members of Orchidaceae. *Bulbophyllum* occupies the first position with 105 species followed by *Dendrobium* with 103 species, *Habenaria* present in third position with 59 species in India (Choudhary *et al.,* 2011; Singh *et al.* 2001). Studies on distribution and diversity of *Habenaria* by Choudhary *et al.* (2011) documented 26 species in Karnataka. While working on Flora of Shimoga district, Ramaswamy *et al.* (2001) documented five *Habenaria* species. Prashantha (2016) studied the biology of some orchids in Shimoga district and observed 6 species of *Habenaria* in the district. According to IUCN Red list status, all the documented species come under Not Evaluated (NE) Category but regionally six species are common and remaining species are rare to the study area (Fig. 2).

There are some threats that may alter the phenology of orchid species. Change in rainfall, collection of flowers from the wild, destruction of habitats, road construction, landslides, forest fires *etc.* are the major causes for the depletion of terrestrial orchid diversity. There should be an immediate need to take some measures for the conservation of terrestrial orchid diversity. During the present investigation, an effort has been made to assess the diversity, distribution and phenology of *Habenaria* species in Shimoga district, and the present results may help to give new approach for the conservation and cultivation of these terrestrial orchid species. The importance of conservation of these terrestrial orchid species and their habitats in the district is emphasized.

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