

The fate of *Diplomeris hirsuta* (Lindl.) Lindl.: A vulnerable Orchid in Darjeeling region of eastern Himalaya, India

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ABSTRACT

The present communication investigates the population and habitat assessment of *Diplomeris hirsuta* (Lindl.) Lindl. (Orchidaceae) in Darjeeling region of eastern Himalaya, India over a period of three years. The method of quadrat sampling was followed and it was observed that the data show a reduction in the average population count of the species from 13.58 to 9.41 with a decline of about 20 to 25 percent including variation in the importance value index from 116.73 to 98.34 over a study period. The fate of the orchid is under tremendous threat and is likely to become extinct from its present vulnerable categorization if the frequency of population decrease continues at this rate. Proper conservation strategy is utmost necessary at this point for its survivability.

Key words: *Diplomeris hirsuta*, Vulnerable, Darjeeling, eastern Himalaya

Introduction

Orchids are the second largest angiospermic families of flowering plants after Asteraceae (Chase *et al.*, 2015). It possesses one of the most highly evolved floral specializations and is well diversified monocotyledons. Around 31,000 species are present globally (Joppa *et al.*, 2010) out of which 29,199 species have been accepted (Govaerts *et al.*, 2017). Each year hundreds of new species names are being published (Schuiteman, 2017). Most of the orchid taxa are annual or perennial with epiphytic, lithophytic or terrestrial in their habitat. They have fascinated people as they possess highly ornamental flowers (Handa, 1986).

The orchid *Diplomeris* was first established in 1825 in works of *Prodromus Florae Nepalensis* (Hamilton and Don, 1825). The genus comprises four species in the Eastern Himalayan region, occur-

ring in India, Nepal and China. One of the terrestrial species, *Diplomeris hirsuta*, is native to ranges of Himalaya to Central China, Nepal, Western Bhutan and Eastern India. It is also referred to as *Snow Orchid*, and its etymology originates from the Greek word 'diplo' and 'merus' meaning double and portion respectively, due to the presence of the divided stigma, appendix-like projections on the column (Pearce and Cribb, 2002). *Hirsuta* means 'hairy', in Latin, with reference to the leaves, stem and ovary of the species (Jalal, 2012).

The accepted nomenclature for the species is *Diplomeris hirsuta* (Lindl.) Lindl. Gen. Sp. Orchid. PL: 330 (1835). Type: Nepal, Gossainthan, Wallich's collectors Wall. Cat. 7065, with synonym *Diplochilus hirsuta* Lindl. (Ohashi, 1972). The ecological niche for the species is on mossy rocks, beside brooklets or road sides in moist open walls with shady habitat. This species is noted for its few scattered distribu-

tion within a limited range. It was initially reported from Nainital by (Rau and Arora, 1973), the only known locality of *Diplomeris* in the Western Himalaya. In eastern Himalayan region the species has been reported from West Kameng district of Arunachal Pradesh (Chowdhery, 1998). Earlier record of the taxa is from Nepal and Bhutan but with no proper identified location and four occurrences have been confined to the present study area itself (GBIF, 2020). This orchid has been categorized as Vulnerable in the IUCN Red Data Book (Nayarand Sastry, 1987) and it is also banned under CITES Appendix II. However, under the Biological Diversity Act 2002, with reference to Schedule-38 of the Act, out of large number of orchid taxa that were proposed to be declared as threatened, 12 species have been categorized as threatened and another 8 have been proposed among which *Diplomeris hirsuta* is one of the species (Agarwala and Singh, 2013). Its vulnerability through landslides and habitat encroachment was first recorded in the mid-70s (Pradhan, 1974).

Materials and Methods

Study Area

The Darjeeling Himalaya is located as a spur in the lap of the eastern Himalaya and extends between 27° 13' 10" N to 26° 27' 05" N Latitudes and 88° 53' E to 87° 59' 30" E Longitudes. It is a hilly region in the northernmost end of the Eastern India situated in the form of an inverted wedge. Darjeeling Himalayan region is drained by numerous streams and rivers like Teesta, Rangit, Mahananda, Jaldhaka, Balason, Mechi, Lish, Gish, Murti etc. The pristine

beauty and the floristic diversity of Darjeeling Hills is well known and is considered to be a treasure house of myriad of floral and faunal elements. Not only the resident species, but huge numbers of exotic species are also found to be naturalized in this Himalayan belt due to the greater number of tourists who are attracted to the natural beauty and wealth of the hill. Due to the distinct altitudinal variations between the plains and the mountainous regions, the species richness varies within short altitudinal ranges. The Darjeeling Himalaya harbors around 311 orchid species under 85 genera, out of which around 77 species are terrestrial (Yonzone *et al.*, 2012), of which *Diplomeris hirsuta* is one of the species with limited ecological niche.

The present study was conducted at the only known habitat of *Diplomeris hirsuta* in Darjeeling Himalaya along National Highway 31A on the left between Coronation Bridge (26°54'9.50"N to 88°28'20.39"E), Sevoke uphill upto around 2.5 – 3 km on the road side walls parallel to river Teesta (Fig. 1). The distributional niche for the species lies on the sub-tropical zone with altitudinal range between 250 to 800 m amsl. The mean annual temperature for the area varies between 24 °C to 28 °C with around 31 °C during the growing season for the species. The average annual precipitation remains 3200 mm. The forest surrounding the habitat harbors a mixture of sub-tropical tree species like *Tetrameles nudiflora*, *Pandanus furcatus*, *Trema orientalis*, *Macaranga denticulata*, *Ailanthus integrifolia*, *Duabanga grandiflora*, *Gynocardia odorata*, *Gmelina arborea*, *Diploknema butyracea*, *Callicarpa arborea* and *Litsea cubeba*. Shrubs and climbers in the sub-tropical habitat include species like *Woodfordia fruticosa*, *Dioscorea alata*, *Mikania micrantha*, *Leea guineensis* *Thunbergia grandiflora*, *Ampelocissus sikkimensis*, *Ficus hederacea*,

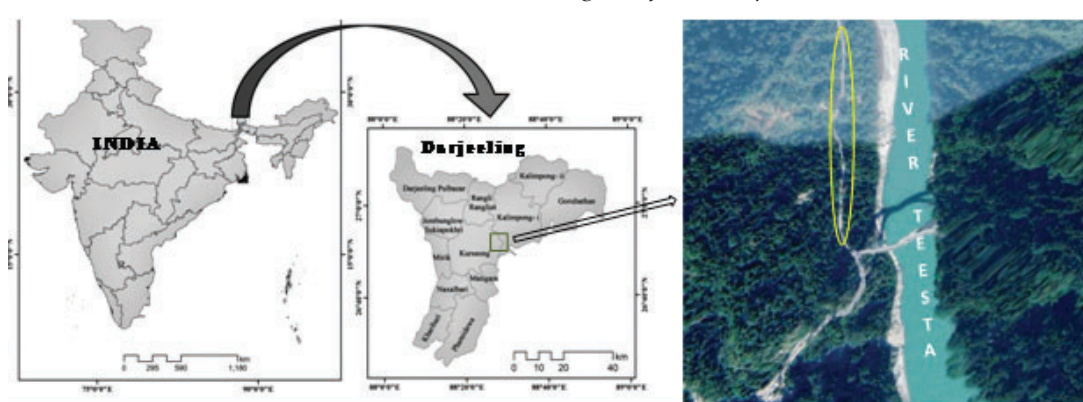


Fig. 1. Map showing study area with orchid habitat (marked yellow)

Debregesia longifolia, *Stephania glabra*, *Tetrastigma serrulatum*, *Bauhinia vahlii* and the herb and grasses include species such as *Commelina suffruticosa*, *Globba racemosa*, *Globba teesta*, *Pogonatherum crinitum*, *Elatostema lineolatum*, *Colocasia affinis*, *Adiantum lunulatum*, *Utricularia brachiata*, *Saccharum longesetosum*, *Begonia hatacoa*, *Aleuritopteris bicolor*, *Diplazium esculentum* etc. The realized niche for *Diplomeris hirsuta* is mostly associated with species of *Colocasia*, *Elatostema*, *Chrysopogon*, *Begonia*, *Globba*, *Adiantum* and *Selaginella* including some hepatics.

Population Sampling

The population and habitat assessment for *Diplomeris hirsuta* was conducted during 2016 and 2019 during its peak growing season July-August. A quadrat sampling method was followed for estimating the frequency, density and abundance of the species along with the associated species within the quadrat. A plot size of 1 x 1 m was placed on its habitat with the help of yard stick and the number of individual count of *Diplomeris hirsuta* was done along with the number of other associated taxa. The morpho-taxonomic discourses have been carried out in the field itself. A total of 12 quadrats were placed within the limited distributional range both in the year 2016 and 2019. These fixed quadrats were placed in such a way so as to include at least 7-8 individuals of the species.

The individual data count was then tabulated and pooled by plots to compute and estimate fre-

quency, density, abundance, and abundance to frequency ratio (Curtis and McIntosh, 1950; Phillips, 1959). The relative values were summed up to determine importance value index. The abundance to frequency ratio (A/F) was estimated to understand the spatial distribution pattern of the species. A brief account of the nature of population of the species within the time frame of three years was studied and analysed.

Results

Taxonomy

The species is terrestrial and mostly lithophytic on moist and damp rocks on the walls. Plant height about 5 – 7 cm; tuber spherical-ellipsoid with 0.5 – 1 by 0.5 – 0.8 cm. Stem are short, sparsely pubescent, 2 – 3 cm. Single leaf (sometimes with another small sub-opposite leaf) at the basal position with oblong shape and sub-acute apex, sessile, stiffly pubescent, sheathing. Inflorescence with 1 to 2 flowered; floral bract ovate, acute, stiffly pubescent. Flower 2 – 2.5 cm wide, white; pedicel and ovary narrowly oblong, pubescent. Dorsal sepal ovate-oblong, sub-acute, sparsely pubescent, 1 – 1.3 cm; lateral sepals oblong-ovate, pubescent (Fig. 2A). Petals orbicular-reniform, sub-acute, 1 – 2.2 by 0.8 – 1.8 cm. Lip simple, spurred, clawed at base; apical lobe broadly ovate-orbicular; apex bi-lobed, emarginate, mucronate; spur long, funnel shaped at base tapering below and curved, pubescent 3.5 – 5 cm long. Column 6 – 7 mm; stigma 2, oblong, erect, broadly ovate with irregularly lobed margin; anther locules triangular with long tubes, 5 – 6 mm long; staminodes small, oblong; pollinia cylindrical; caudicle long. The flowering period falls during the month of June to August.

Habitat Assessment

The result obtained through habitat study of *Diplomeris hirsuta* showed 10 associated species under 9 genera belonging to 7 families that remained within the orchid habitat, with *Elatostema lineolatum* and *Colocasia affinis* showing much dominance followed by *Begonia hatacoa* and *Chrysopogon gryllus*. Two species of fern *Adiantum lunulatum* and *Aleuritopteris bicolor* were also found to be associated closely along with *Selaginella* sp. and one species of minute epiphyte *Utricularia brachiata* (Fig. 2B).

However, the calculations made on the observed data showed that there have been tremendous de-

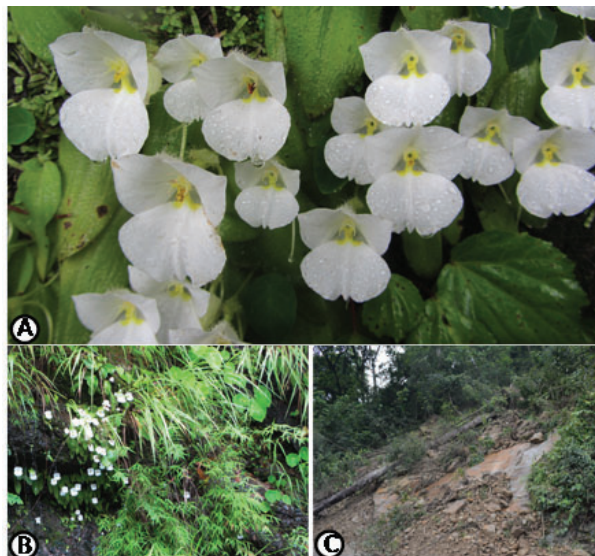


Fig. 2. A : *Diplomeris hirsuta* in full bloom B: Orchid habitat C: Landslide at the habitat site

cline in the population count of the species within this span of time. It was observed within the fixed quadrat, there was a reduction in the average population count of the species from 13.58 to 9.41 with decrease of about 20 to 25 percent in population in the placed quadrat within the study period. The calculation showed a decline in the density and abundance also from 13.6 to 9.4 with change in importance value from 116.73 to 98.34 (Table 1). Among the associated species, *Elatostema lineolatum* and *Colocasia affinis* expressed maximum IVI score of 31.07 and 24.14 respectively followed by *Begonia hatacoa* and *Chrysopogon gryllus*. The minimum score of 8.44 was estimated for *Utricularia brachiata* with only three individual count during the year 2016 which however increased slightly later. The calculations made thereafter three years, showed similar score for the associated species with slight increase in the IVI score of *Elatostema lineolatum* and *Colocasia affinis*. However, the calculations showed that fern *Adiantum lunulatum* scored slightly more and species like *Chrysopogon gryllus* and *Begonia hatacoa* expressed reduced IVI during 2019. Based on the abundance to frequency ratio, it was observed that the distribution pattern for the orchid was contiguous in its niche.

Discussion

The habitat for the orchid *Diplomeris hirsuta* is very limited to the study site and there are no any records of its occurrence in any other places in Darjeeling Himalaya. As it was observed in the present study, there has been a decline in the population of this vulnerable species with limited ecological ampli-

tude. The Darjeeling Himalaya is one of the several marked avalanche zones in the Himalayan region (Bhandari, 2004). The mountainous terrains are characterized by high energy with instability and variability of the masses. Landslides are the significant form of natural disaster that causes the loss of properties and lives (Gerrard, 1994). The variable geomorphology and neo-tectonic activities resulting in the region being highly prone to earthquakes. The zone is geologically very fragile and noted as seismic zone IV (Negi, 2018). The pivotal causes of the landslides are also the variable degree of intensive rainfall including earthquake (De, 2004). The heavy concentration of rainfall during short span, especially during June to August is one of the main reasons for the landslides to occur in the habitats of the orchid along NH 31A thereby affecting the species population (Fig. 2C). However, it was observed that some of the associated taxa in the orchid habitat showed quick regeneration than the orchid itself. The Teesta basin in recent times is one of the most landslide prone areas of the nation, a huge sediment load to the river is contributed. The vegetation is being continuously disturbed due to soil erosion that affects the peak growing season of *Diplomeris hirsuta* along the highway which is the only known niche for the orchid.

While several Hydel power projects have been set up on the river Teesta at different sites causing a major threat to the biodiversity loss in this region with social impact on the inhabitants of the villages adjoining the river. The stage IV dam proposed by NHPC at Coronation Bridge are low and run off river dams that would submerge around 359.89 ha forests and would also result in the realignment of

Table 1. Community association of orchid with other taxa in the habitat

Species	2016					2019				
	F	D	A	A/F	IVI	F	D	A	A/F	IVI
<i>Adiantum lunulatum</i> Burm. f.	41.7	0.9	2.2	0.053	17.83	41.7	1.3	3.2	0.077	24.93
<i>Aleuritopteris bicolor</i> (Roxb.) Fraser-Jenk.	25.0	0.5	2.0	0.080	12.54	25.0	0.6	2.3	0.093	15.20
<i>Begonia hatacoa</i> Buch.-Ham. ex. D.Don	66.7	1.3	1.9	0.028	22.62	66.7	1.0	1.5	0.023	21.86
<i>Colocasia affinis</i> Schott	75.0	1.3	1.8	0.024	24.14	75.0	1.3	1.8	0.024	25.99
<i>Diplomeris hirsuta</i> (Lindl.) Lindl.	100	13.6	13.6	0.136	116.73	100	9.4	9.4	0.094	98.34
<i>Elatostema lineolatum</i> Wight	75.0	2.2	2.9	0.039	31.07	75.0	1.9	2.6	0.034	31.65
<i>Globba racemosa</i> Smith	25.0	0.5	2.0	0.080	12.54	25.0	0.6	2.3	0.093	15.20
<i>Globba teesta</i> Nirola & Das	33.3	0.6	1.8	0.053	13.59	33.3	0.7	2.0	0.060	15.97
<i>Chrysopogon gryllus</i> (L.) Trin.	50.0	1.2	2.3	0.047	20.75	50.0	0.8	1.7	0.033	18.64
<i>Pogonatherum crinitum</i> (Thunb.) Kunth	58.3	1.0	1.7	0.029	19.62	58.3	0.9	1.6	0.027	20.21
<i>Utricularia brachiata</i> Oliv.	25.0	0.3	1.0	0.040	8.44	25.0	0.4	1.7	0.067	12.10

NH 31A (Rudra, 2003). The huge construction works and the reservoirs built would enhance the risk of seismicity. As the habitat of the orchid is along the walls on the road sides, the frequency of daily transportation is extremely high on this route, as it is the only route within Darjeeling Terai that connects the state of Sikkim with the rest of the country. Since the geological formation in this zone is fragile, the vibration that occurs due to extreme transportation is also one of the chief reasons for loosening of the rocks on the walls and erosion of the soil and landslides in this hilly tract. Beside these, air and noise pollution is also a considerable problem in the area and the disposal of sewages in and around the construction places where the workers reside have also become a major cause of pollution in the river affecting aquatic ecology (Lakra *et al.*, 2010). The threats that are being associated to the diversity of orchid are continuing at an alarming rate. The decline in the population of *Diplomeris hirsuta* is affected severely due to such multiple activities, be it natural or anthropogenic. The species is already in distress condition in the Western part of the Himalaya too with limited distribution and if proper strategies are not approached at this point, then the day is not too far for the species to be categorized from vulnerable to critically endangered towards extinct.

Conclusion and Recommendation

The present communication that highlights the status of *Diplomeris hirsuta* expresses a matter of concern. The survivability and fate of the orchid in its fragile habitat ecosystem is at high risk with possible decline of the population annually. If the frequency of population deteriorates at the present estimated percent, then the time is not so far for the species to be on the verge of extinction from its present vulnerable condition in this part of the Himalaya. Active participation of environmentalist, conservationist, orchidologist is must to keep an eye on the species with proper consultation with the surrounding local community. Introduction of the species in nearby forest and similar habitats, multiplication through tissue culture and micro-propagation and thereby hardening and planting in likely environment or suitable horticultural practices is the only option that remains for the species to conserve in future. Study on regeneration behavior, seedling ecology, reproductive morphology will act as a boon for un-

derstanding the species survival. Else, at this frequency of threats and rate of population loss, the species that is already under vulnerable category will be on the threshold of becoming extinct from this part of the Himalaya.

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