J. Pl. Res. Vol. 18, No. 1, pp 157-162, 2020

Diversity of Phorophytes Selected by Epiphytic Orchid *Vanda cristata* Wall. ex Lindl. (Orchidaceae) in Central Nepal

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Abstract

Epiphytic orchids, which live non-parasitically on another plant (host or phorophyte) are the important component of global plant diversity, and occurdiversely in tropical and sub-tropical forest of Nepal. However, little is known about the specificity of the relationship between epiphytic orchids and their host tree species in Nepal. Host specificity relationship was assessed for the epiphytic orchid *Vanda cristata* Wall. ex Lindl. in tropical and sub-tropical forest of Jugu, Central Nepal. To record the local abundance and geographical distribution, a rating system was used. The result showed that majority of orchid-host associations were locally sparse and restricted geographically (42.10 %), followed by locally sparse and widespread (21.05 %). *Vanda cristata* was seen as generalist species because it was found colonized on 19 different host tree species (phorophytes). Thus, non-specific nature of association of this orchid with host trees was detected.

Keywords: Epiphytes, Host species, Host specificity

Introduction

Epiphytes, which contribute about 10 percent of total vascular species (Kress, 1986) are diverse and important component of global plant diversity. They live on another plant (host plant or phorophytes) for the structural support and anchorage, thus known as structurally dependent plants (Wagner et al., 2015). Epiphytic orchids, which belongs to the family Orchidaceae, includes some threatened species and encompass up to 70% of total vascular epiphytic species (Madison, 1977), occur diversely in tropical and subtropical forest of the world (Nieder et al., 2001).

Epiphytes are broadly classified into two groups: holo-epiphytes (spending their entire life on the host tree) and hemi-epiphytes (spending only part of their life cycle on host tree) (Benzing, 1990; Nieder et al., 2001; Bhatt et al., 2015). Epiphytic orchids are vascular holo-epiphytes. Due to complex habit, perfect suit of environment is necessary for their survival and growth. Therefore, to adapt in epiphytic habit, they have developed some special morphological and physiological adaptations. For example, succulent leaves and stems, pseudobulb as storage organ, sunken stomata, CO_2 uptake via. CAM pathway, roots with velamen redicum and impermeable cuticles, which help them to adapt successfully even in the poor nutrient and water supply conditions and led them to an outstanding success in epiphytic habitat (Zotz & Winkler, 2013).

Epiphytic orchids constitute an important position in the flora of Nepal. So far, 256 species of epiphytic orchids have been discovered from the country, and still are in the process of documentation (Rajbhandari & Rai, 2017; Shrestha et al., 2018; Raskoti & Ale, 2019). They are distributed from 60 m to 5200 m asl in Nepal (Rokaya et al., 2013), growing on various habitats and microclimatic conditions. Most of the epiphytic orchids occur in tropical and sub-tropical forests of the country (Acharya et al., 2011).

Studies on host specificity analysis are very few in the Nepalese context. In other parts of the world, studies have shown that epiphytic orchids have host preference and that depends on the host traits (Callaway et al., 2002; Merwin et al., 2003). It has been suggested that successful seedling establishment on a phorophyte depends on biotic and abiotic factors like tree bark roughness, host size, bark porosity, height, bark chemistry (e.g., pH, plant exudates) and suitable mycorrhizae (Johanson, 1974; Callaway et al., 2002; Trapnell & Hamrick, 2006;

Adhikari & Fischer, 2011). Trapnell & Hamrick (2006) suggested that presence of suitable mycorrhizae is the most critical factor because orchid seed lacks endosperm and requires suitable mycorrhizal infection for carbon uptake before germination. This study is aimed to assess the diversity of phorophytes colonized by epiphytic orchid *Vanda cristata* in tropical and sub-tropical forest of Central Nepal.

Materials and Methods

Study species

Vanda cristata is the perennial epiphytic orchid first collected in 1818 AD by Nathaniel Wallich in Nepal and described by John Lindley in 1832. It is distributed in Bhutan, Nepal, India, N. Vietnam, Thailand, Myanmar, Bangladesh and China (geographical distribution) (Roskov et al., 2019). In Nepal, it is distributed in Central and Eastern Nepal from 920 m to 2300 m (Rajbhandari & Rai, 2017). It is monopodial epiphytic orchid (holo-epiphyte) with yellowish-green fragrant flowers (Figure 1). Single inflorescence can produce 1 to 3 flowers and usually 1 or rarely 2 healthy pods. Flowers are thickly textured with wide openings. Petals are falcate, lip golden yellow to white, three-lobed and spurred. This species loves middle and lower trunks of host trees. Flowering time of *V. cristata* is from May to July.

Figure 1. Study species *Vanda cristata* Wall. ex Lindl.

Vanda cristata Wall. ex Lindl. has medicinal importance. The paste prepared from the root is used to treat dislocated bones, cut and wounds and leaf powder as expectorant (Manandhar, 2002; Subedi et al., 2013). Similarly, the plant bear attractive flowers, so used as ornamental plant in home gardens. Thus, concerning the diverse use-values, this species is recognized asone of the most important orchid species of Nepal.

Study area

The study was carried out in tropical and sub-tropical forest of Jugu (now Gaurishankhar Rural Municipality) Central Nepal, with coordinate between 27º 53' N to 27.88º N latitudes and 86º 24' E to 86.40º E longitudes (Figure 2). The climate ranges from warm tropical, subtropical monsoon and cool temperate. There is high rainfall during monsoon period (June to September) and account for about 80 percent of the total annual rainfall. According to the report of the nearest Jiri weather station, the area receive an average precipitation of 2427.817 mm. The annual mean minimum and maximum temperature are 8.17°C and 20.71°C, respectively (Karki, 2019).

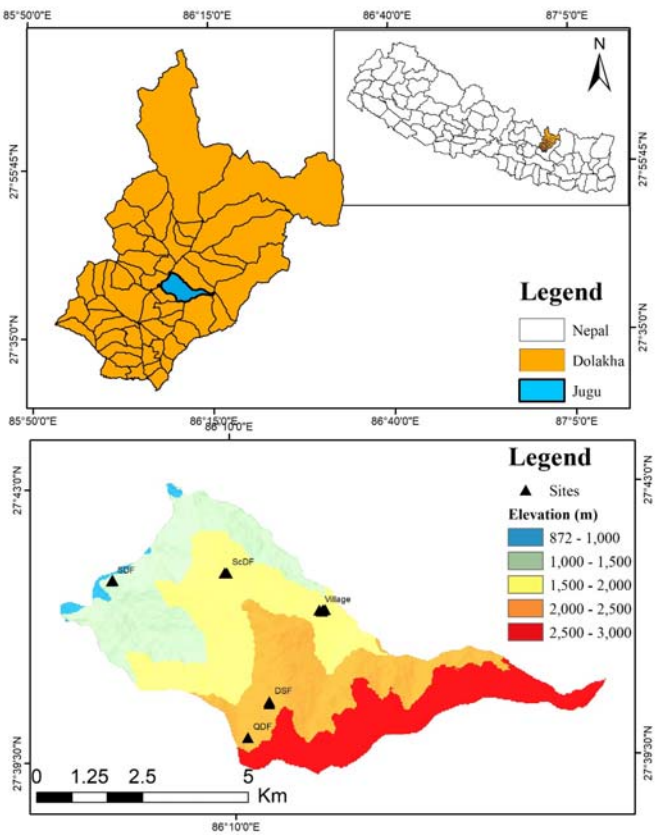

Figure 2: Map of Dolakha district showing study area

Data collection

The study was based on both repeated field surveys and literature reviews. Observations of different forest types (e.g., sal forest, riverine forest, *Schima-Castanopsis* forest and mixed pine forest) of Jugu were systematically made. The population of epiphytic orchid *Vanda cristata* along with their host trees and locations were recorded. The variety of phorophyte species colonized by *Vanda cristata* was photographed and identification of host species was made. The family of each host species was also identified.

In each site, the number of host individuals supporting *Vanda cristata* was recorded. A method known as rating system (Trapnell & Hamrick, 2006), similar to that of Rabinowitz (1981), was used to account the local abundance of host trees supporting *V. cristata* and geographical distribution of that orchid-host association (Table 1). In this method, based on the abundance of epiphytic orchid on host trees, theirlocal status was categorized into three different categories viz. locally abundant (A), locally sparse (S) and locally occasional (O). For occurrence of *V. cristata* on a particular tree species to be rated as 'A'; several to many individuals of that tree species had to support *V. cristata* at each site. A rating 'S' indicates that, if only few individuals of that tree species support *V. cristata* at each site. Similarly, rating 'O' was given in cases where some locations had less than three trees with orchids, while other locations had many trees of that species supporting *V. cristata* (Trapnell & Hamrick, 2006). Similarly, following Trapnell & Hamrick (2006), the geographic distribution of trees having *V. cristata* was recorded for each host/ phorophyte species as widespread (W) or restricted (R). A rating 'W' indicated that, the host tree has wide distribution, whereas rating 'R' indicated the narrow distribution of host species in the study area.

Results and Discussion

Vanda cristata was found colonized on 19 different host species (Table 2). This shows *V. cristata* is not host-specific orchid species. Although, this number is not exact because many areas were not systematically studied. Most common host species colonized by *V. cristata* was *Prunus cerasoides* (Rosaceae). However, *V. cristata* was also frequently observed on *Shorea robusta, Ficus nerifolius* and *Schima wallichii*. The association of *Vanda cristata* with multiple host species indicated that, it has high ability to establish population on several phorophytes, which is a good emblem of long-term survival potential of this species.

These results concur with the distribution of another epiphytic orchid species *Rhynchostylis retusa,* which is morphologically similar with *V. cristata* (Adhikari & Fischer, 2011). In many host species, *V. cristata* was observed at only once in the study sites. Although, there was good abundance of other trees (*Pinus roxburghii*, *Dalbergia sissoo* and *Myrica esculenta*) in the study sites, but we didn't find the association of *V. cristata* on those tree species. It seems unlikely that seed of *V. cristata* doesn't fall on the trunk of those trees, but it is predictable that such trunk lack appropriate substrate and mycorrhizae for the germination of *V. cristata* seedlings.

The result showed that the abundance of *V. cristata* on host trees at locality were locally sparse (63.15%), of which majority of orchid-host associations were locally sparse and restricted geographically (8 species, 42%), followed by locally sparse and widespread (4 species, 21.05%) (Table 2).Twelve associations were seen as locally sparse (63.15%), of which four (21%) were widespread and eight (42.10%) were recorded within restricted geographical range (Table 1 and 2). Similarly, three species have restricted and occasional distribution (15.78%) and two species have wide spread and locally abundant distribution (10.52%) (Table 1). This indicates, although *V. cristata* have wide range of host species, the abundancewas locally sparse and distribution was restricted to few sites only. Sparse local abundance of *V. cristata* in some sites was due to the sparse occurrence of host tree species (For example: *Ficus carica*, *F. sarmentosa* and *Fraxinus floribunda*). These findings agree with the findings of Trapnell & Hamrick, (2006) on the host-orchid associations of neotropical orchid *Laelia rubescens*.

However, in our study locally abundant *V. cristata* also have restricted geographical distribution (5.26 %), which differ from previous result of Trapnell & Hamrick, (2006).

In addition, it was observed that *V. cristata* was also found in degraded habitat. Thus, it is predictable that *Vanda cristata* can tolerate some level of disturbances and pollution. *Vanda cristata* has large, long roots and thick leaves, which might be advantageous to tolerate some degree of disturbances.In general, our study supports the previous findings, such as large-sized trees supports more species, high bark rugosity supports many species (Callaway et al., 2002; Hirata et al., 2008). Regardless, many individuals were seen adapted successfully even on trees with less rugose bark and on branches of small size. In some trees, even small twig (less than 10 cm diameter) also supported many individuals. It indicate that, in particular site, host bark rugosity and host size are less important for the occurrence of *V. cristata*. Other various microclimatic factors might be responsible for their occurrence in those sites.

In most of the study sites, *V. cristata* was recorded in the lower and middle trunk zones of host trees forming a patchy populations, covering the host trunk by their large roots, indicating that these layers are suitable for the growth. The reason behind the successful establishment of *V. cristata* on lower layer of host tree might be due to high substrate stability and moisture in lower trunk layers compared to upper layers. They are normally associated with other epiphytic orchid species, such as *Vandopsi sundulata, Oberonia pachyrachis, Pholidota articulata* and *Dendrobium heterocarpum* and hemi-parasitic species, such as *Hoya linearis, Lepisorus* sp., *Scrrula elata,* and *Drynaria mollis*.

Table 2: Phorohyte species of epiphytic orchid *Vanda cristata* Wall. ex Lindl.

S.N	Phorophyte	Family	Occurrence of *Vc* association
1.	*Acacia catechu*	Fabaceae	RS
2.	*Alnus nepalensis*	Betulaceae	WS
3.	*Buddleja asiatica*	Scrophulariaceae	RO
4.	*Engelhardia spicata*	Juglandaceae	WS
5.	*Euphorbia royelena*	Euphorbiaceae	RS
6.	*Eurya acuminata*	Theaceae	WS
7.	*Ficus carica*	Moraceae	RS
8.	*Ficus nerifolius*	Moraceae	RS
9.	*Ficus religiosa*	Moraceae	WO
10.	*Ficus sarmentosa*	Moraceae	RS
11.	*Fraxinus floribunda*	Oleaceae	RS
12.	*Juglans regia*	Juglandaceae	WS
13.	*Mangifera indica*	Anacardiaceae	RO
14.	*Prunus cerasoides*	Rosaceae	WA
15.	*Quercus glauca*	Fagaceae	RS
16.	*Sarauria napaulensis*	Sarauriaceae	RO
17.	*Schima wallichii*	Theaceae	WA
18.	*Shorea robusta*	Dipterocarpaceae	RA
19.	*Wendlandia heynei*	Rubiaceae	RS

Note: RS = Restricted, locally sparse, WS = Widespread, locally sparse, RO = Restricted, locally occasional, WO = Widespread, locally occasional, WA = Widespread, locally abundant, RA = Restricted, locally abundant

Conclusion

From the result, *Vanda cristata* showed generalist behavior and tend to establish population on more than single host species rather than on a particular

Table 1: Frequency of epiphytic orchid *Vanda cristata* (*Vc*) found on phorophytes locally and over the orchid's geographical range in forest of Central Nepal. Percentages are of 19 host tree species (see table 2) supporting *Vc* in each classification.

Abundance of *Vc* on phorophytes at locality	Geographical range of Phorophytes/ *Vc* association	
	Widespread (W)	Restricted (R)
Locally abundant (A)	*Vc* on many trees locally. Association with phorophyte widespread geographically. (10.52 %)	*Vc* on many trees locally. Association with phorophyte restricted geographically to one or few sites. (5.26%)
Locally occasional (O)	*Vc* on varying numbers of trees locally. Association with phorophyte widespread geographically. (5.26 %)	*Vc* on varying numbers of trees locally. Association with phorophyte restricted geographically to one or few sites. (15.78 %)
Locally sparse (S)	*Vc* on one to a few trees locally. Association with phorophyte widespread geographically. (21.05 %)	*Vc* on one to a few trees locally. Association with phorophyte restricted geographically to one or few sites. (42.10%)

host species. Therefore, it seems that the future perpetuation potential of this species is high, although orchid-host associations were locally sparse and restricted geographically in the study area. Host preference was biased towards the host trees having thick, rugose bark and tree withlarge size. However, different underlying mechanisms might be there for the successful host-epiphyte associations and host preference. Therefore, future research work should use a comprehensive approach for determining host traits, the role of mycorrhizae and microclimatic conditions in order to give some rigorous conclusions about the host specificity.

Acknowledgements

Authors would like to acknowledge the head of Central Department of Botany for the administrative support. The help of local peoples in the field are highly acknowledged.

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