

Research Article

Restriction of *Viscum Album* to Few Phorophytes in a Habitat with Diverse Type of Tree Species

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Abstract

Viscum known for 464 species is distributed from temperate to tropical world as is a hemi-parasite on tree species. Commonly called as mistletoes, the members of the group show normal parasitic, facultative, or rarely tripartite associations. Mistletoes are also known for auto parasitism, where individuals of the same species parasitize on the same species of mistletoe growing on the host trees. In the present study, *V. album* is reported on three cultivated host species i.e. *Juglans regia* L., *Prunus armeniaca* L. and *Salix alba* L. only, however, the study area is characterized with the number of other tree species also. In order to understand the specificity of the hemi-parasite on these three phorophytes, a seed germination test of *V. album* has been conducted on other eight tree species in the same geographical area.

Keywords: Temperate NW himalaya; Parasitism; Phorophyte; Auto-parasite; Host specificity

Introduction

Viscum is a hemi-parasite on several tree species and comprises about 464 species widely distributed from temperate to tropical climates in Europe, Africa, Asia, and Australia [1]. Morphologically, *V. album* is 30–100cm long, dichotomously branched with yellowish-green, opposite, strap-shaped, entire, leathery leaves measuring 2–8 X 0.8–2.5cm. During reproductive phase species bears insect – pollinated, unisexual, yellowish-green flowers measuring 2–3 mm in diameter. The fruit is white or yellow berries containing one (very rarely several) seed embedded in the very sticky, glutinous fruit pulp [2]. Traditionally, the genus has been placed in family Viscaceae, but on the basis of molecular studies now-a-days all the members of Viscaceae are merged into the Sandalwood family i.e., Santalaceae [3,4]. In general the pattern of host specificity in mistletoes covers

a wide spectrum from highly host specific to host generalists [5,6,7]. Some mistletoe parasitizes a large number of hosts in different families. e.g., *V. album ssp. album* on more than 450 host species and a few mistletoes e.g., some dwarf mistletoes parasitize only one host species [8,9]. The host specificity of dwarf mistletoes may be a useful taxonomic character for distinguishing between host populations [10,11,12,13]. However, some mistletoe is not common on non-cultivated plants [14]. In addition, many species have been thought of as key species for animals which eat honey and fruit [15,16]. Another fascinating effect of mistletoe host specificity is the propensity of mistletoes to parasitize mistletoe. This facultative association is termed as hyperparasitism [17]. Hyperparasitic mistletoes are recorded from Loranthaceae and Santalaceae [18]. A number of species of *Phoradendron* and *Viscum* also show hyper-parasitism [19,1]. Even more amazing are the rare tripartite associations where a

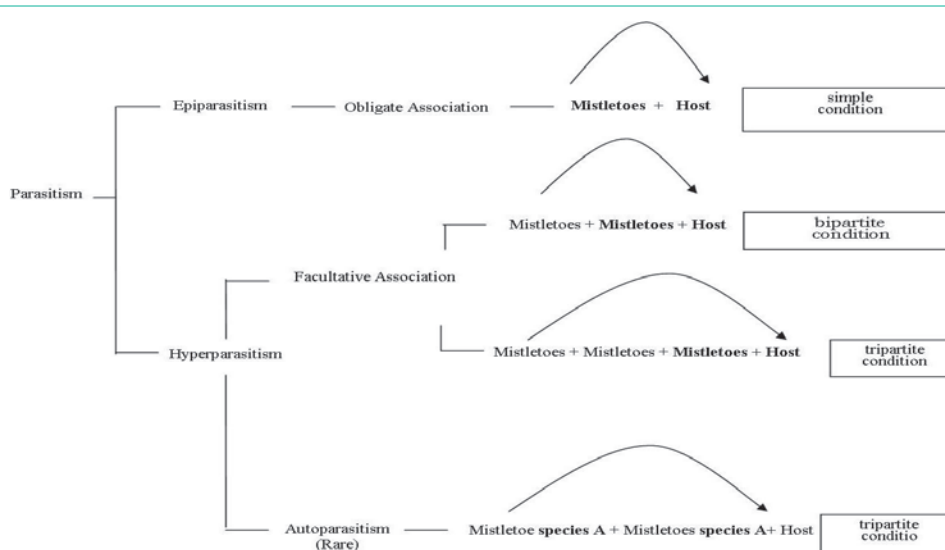


Figure 1: Parasitism.

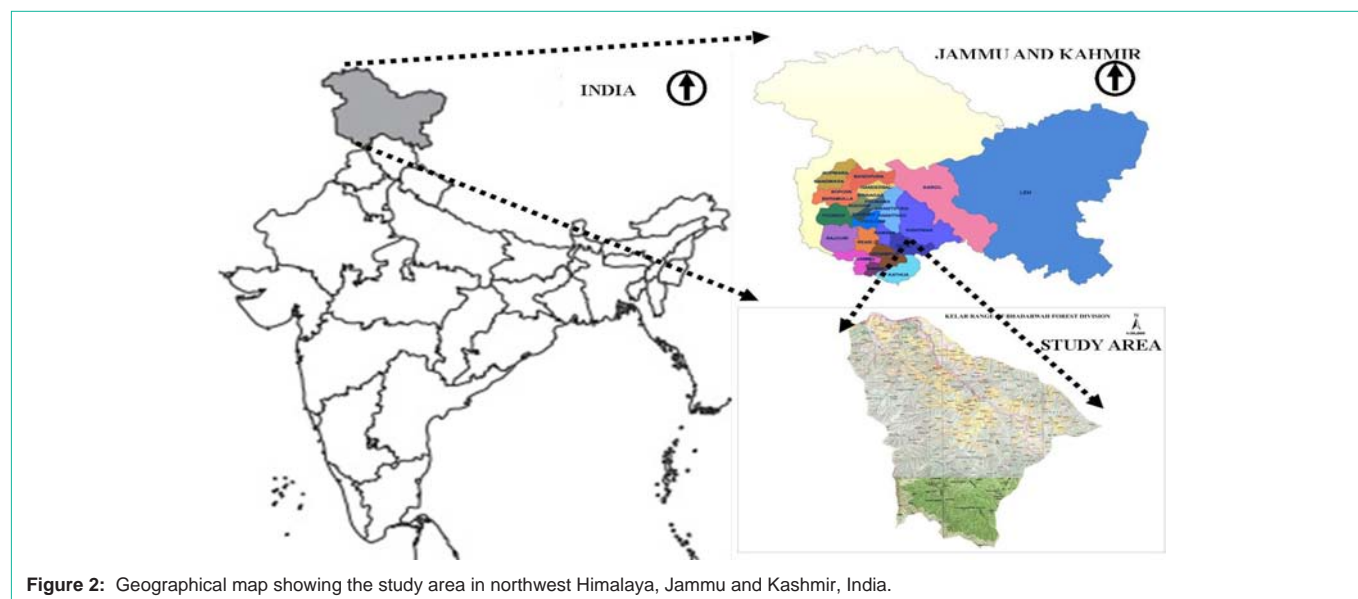


Figure 2: Geographical map showing the study area in northwest Himalaya, Jammu and Kashmir, India.

mistletoe parasitizes a mistletoe that is parasitizing another mistletoe on a host tree [18]. When mistletoe on another mistletoe becomes an obligate association, this is termed epiparasitism *viz* *Phacellaria* [20,17]. Parasitism by an individual of the same species is called auto parasitism. Auto parasitism occurs frequently in Loranthaceae as well as in Santalaceae (Figure 1).

In the present study we have recorded three phorophytes of *Viscum album* i.e *Juglans regia* L, *Prunus armanica* L and *Salix alba* Thunb., however, literature review has suggested 452 species as phorophytes, of which Rosaceous has the maximum hosts (128 taxa) infested by *V. album* [8]. Therefore a study has been conducted to investigate the possibility of new infestations by *V. album* in the study area.

Material and Methods

Study area

Geographical area flanked between E 75°33/24.92 to N33°08/15.99 and E 75°31/09.41 to N33°01/43.44 and divided in two parts by a perennial stream called as Neeru has been selected for the study. This is included in Bhadarwah Forest Division, Jammu and Kashmir and India is designated as Kellar Forest Range (Figure 2). On the right bank of the stream in this forest range, the mountainous forests are dominating by tree species like *Quercus baloot* Griff., *Punica granatum* L., *Daphne oleoides* Schreb and *Olea cuspidata* Wall. However, the mountainous slopes in the forest on left bank of the stream comprises mostly conifers like *Cedrus deodara* Loudon., *Pinus roxburgii* Sarg., *Pinus wallichiana* A.B. Jacks, *Picea smithiana* Boiss and *Abies pindrow* Royle.

Test seed germination on different host

To understand the germination of seeds of the *V. album* on different hosts, seeds of *V. album* collected in the month of November from natural habitat were implanted on stem of *Melia azedarach* L., *Ficus palmata* Forssk., *Alnus nitida* Endl., *Quercus baloot*, *Diaspyros lotus* L., *Cedrus deodara*, *Olea cuspidata* and *Populus ciliata* Wall. The rationality for this experiment was to understand the less distribution and less presence of *V. album* in the study area and its restriction or

specification on *Juglans regia* L., *Prunus armeniaca* L. and *Salix alba* L. only. Percentage of the seed germination has been calculated using formulae

$$\frac{\text{Number of Seeds germinated on tree} \times 100}{\text{Number of Seeds implanted on tree.}}$$

Results

The study area is a temperate forest range NW Himalaya between Pir Panjal and Duladhar range. Due to its location on the left bank of river Chenab, it is also called as extension of Pir Panjal (Figure 2). The study area is known for thick coniferous forest and scrub forests on mountainous slopes of left and right bank of Neeru stream, respectively. Among coniferous trees *Pinus roxburgii*, *Cedrus deodara*, *Pinus wallichiana* are found at low elevations and *Picea smithiana*, *Abies pindrow* at high elevations. Sporadic distribution of *Taxus baccata* L., *Ficus palmata*, *Rhododendron arboretum* Sm., *Viburnum grandiflorum* Wall. ex DC., *Pyrus pashia* Buch.-Ham. ex D. Don and *Trema politra* (Planch.) Blume is also observed in the study area. Beside the *Quercus baloot*, *Punica granatum*, *Daphne oleoides* and *Olea cuspidata* other species on the mountains of right bank includes *Quercus floribunda* Wall and *Dodonea viscosa* Jacb. However, *Alnus nitida* Endl. A broad leaved species is very common along riverine ecosystem in the study area. Other common tree species observed in the study area are horticulture (06), timber (02) and fire wood (03) species (Table 1).

Despite of the fact that the study area is known for many tree

Table 1: Economically important cultivated tree species in the study area.

Horticulture species (6)	Timber species (2)	Fire wood species (3)
<i>Pyrus malus</i>	<i>Juglans regia</i>	<i>Salix alba</i>
<i>Prunus armeniaca</i>	<i>Populus cilata</i>	<i>Populus cillata</i>
<i>Juglans regia</i>		<i>Melia azedarach</i>
<i>Pyrus pashia</i>		
<i>Cydonia oblonga</i>		
<i>Diaspyros lotus</i>		

Table 2: Natural phorophytes and testing of host specificity of *Viscum album*.

Name of the phorophyte/ plant model	Usage and type of resource	Life form of Phorophyte/ plant model	Bark texture of Phorophyte/ plant model	% age of seed germination of <i>V. album</i> on plant model	Status of the implanted seeds of <i>V. album</i> on plant model after 60 days	Status of the implanted seeds of <i>V. album</i> on plant model after 120 days
<i>Juglans regia</i> *	H,c	Tree	Furrowed	NA	NA	NA
<i>Prunus armeniaca</i> *	H,c	Tree	Fissured	NA	NA	NA
<i>Salix alba</i> *	FW,c	Tree	Fissured	NA	NA	NA
<i>Ficus palmata</i> †	F,n	Tree	Fissured	0	–	
<i>Olea cuspidata</i> †	F,n	Tree	Fissured	50	A	nphb
<i>Populus ciliata</i> †	T,c	Tree	furrowed	20	A	nphb
<i>Quercus baloot</i> †	FW,n	Tree	Scaly	0	–	
<i>Alnus nitida</i> †	FW,n	Tree	Smooth	16.6	A	nphb
<i>Diaspyros lotus</i> †	H,c	Tree	Smooth	30	A	nphb
<i>Cedrus deodara</i> †	T,n	Tree	Smooth	40	A	nphb
<i>Melia azedarach</i> †	FW,c	Tree	Smooth	60	A	nphb

* = Natural phorophyte; † = plant model; H= horticulture tree; FW = Fuel wood ; F = Fodder; T= Timber wood; c= cultivated tree; n= natural tree; A=alive, nphb = not penetrated in host bark

Table 3: Mean value of the air temperature and relative humidity during study period.

Months	Air Temperature		Relative Humidity	
	Minimum	Maximum	Minimum	Maximum
February	6.2	15.6	46.1	70.4
March	8.8	19.1	43.5	67.0
April	14.9	23.5	43.9	66.5
May	16.3	25.6	45.2	60.3
June	18.0	30.4	53.6	61.5

species, *V. album* has been observed only on three economically important tree species i.e. *Juglans regia*, *Prunus armeniaca* and *Salix alba*. To understand the restricted distribution of the species on few tree species only, field experiment on seed germination of *V. album* on tree three species has been conducted (Table 2). Seeds of *V. album* were collected from the field in the month of November-December and implanted on the stem of 08 tree species in January (Table 2). The seeds initiated germination on the stem of 06 species i.e. *Melia azedarach*, *Alnus nitida*, *Diaspyros lotus*, *Cedrus deodara*, *Olea cuspidata* and *Populus ciliata* in the month of February. It has also been observed that implanted seeds of *V. album* fail to germinate on the stem bark of *Ficus palmata* and *Quercus baloot* under same climatic conditions (Table 2 & 3), however they germinate on rest of the species after 50-60 days. Germination percentage calculated for the seeds showed maximum value for *Melia azedarach* and the lowest percentage for *Alnus nitida*. The experiment of seed germination has been conducted in the field itself where the air temperature (min/max) and relative humidity (min/max) has been recorded on daily basis (Table 3). After 120 days of implantation of seeds on 08 different species, no penetration of the haustoria of germinated seeds *V. album* has been recorded on any of the tree species.

Discussion

V. album is a partial parasite on tree species and distributed almost all over the world. About 452 tree species are known as the successful host of the species and Rosaceous is considered as the most

frequent host with large number of the tree species as phorophytes. However, commonly infested genera include *Salix*, *Populus*, *Acer*, *Malus*, *Prunus*, *Sorbus*, *Abies* and *Pinus* [21]. It is understood that seed of many plant parasites germinates only in response to chemical signals from host plants [21]. In our study *V. album* is observed on three cultivated hosts i.e. *Juglans regia*, *Prunus armeniaca* or *Salix alba*, this indicates that the parasite is introduced to the study area along with the cultivated tree species. However, simultaneously no temporal data on the introduction of the host species is available. To understand the host specificity and less distribution of *V. album* on other tree species, seed germination test for *V. album* has been conducted on 03 cultivated and 05 naturally occurring tree species in the study area (Table 1). These tree species are cultivated for number of reasons like *Populus ciliata* for timber, *Diaspyros lotus* as horticultural crop and *Melia azedarach* as fuel wood tree. Variability in the bark texture has been maintained among the tree species subjected for the experimentation, 04 species (*Alnus nitida*, *Diaspyros lotus*, *Cedrus deodara* and *Melia azedarach*) were having smooth bark, 01 each was having scaly (*Quercus baloot*) and furrowed (*Populus ciliata*) and 02 were having fissured bark (*Olea cuspidata*, *Ficus palmata*). During the experiment conducted on seed germination on bark of different tree species maximum seed germination percentage (60%) has been observed on *Melia azedarach* followed by *Olea cuspidata* (50%), *Cedrus deodara* (40%), *Diaspyros lotus* (30%), *Populus ciliata* (20%) and *Alnus nitida* (16.6 %), however seeds were not germinated on *Ficus palmata* and *Quercus baloot* (Table 2). This indicates that type of the phorophyte provide stimulus to germinate the seeds of parasite on it, this is in consonance with the statement made on germination of seeds of the parasites on host only in response to chemical signals from host plants [21]. However, some mistletoe seeds germinate readily in almost all situations. The key limiting step in mistletoe's life cycle is establishment, which is dependent on an appropriate disperser, deposition on a suitable sized branch, and mistletoe-host compatibility [22,23]. The random germination on each type of bark suggests that there is no role of the type of bark on the germination of the seeds. The role of bark texture may be providing a suitable site for seeds when they get shed from the parent plant. The rough barks are

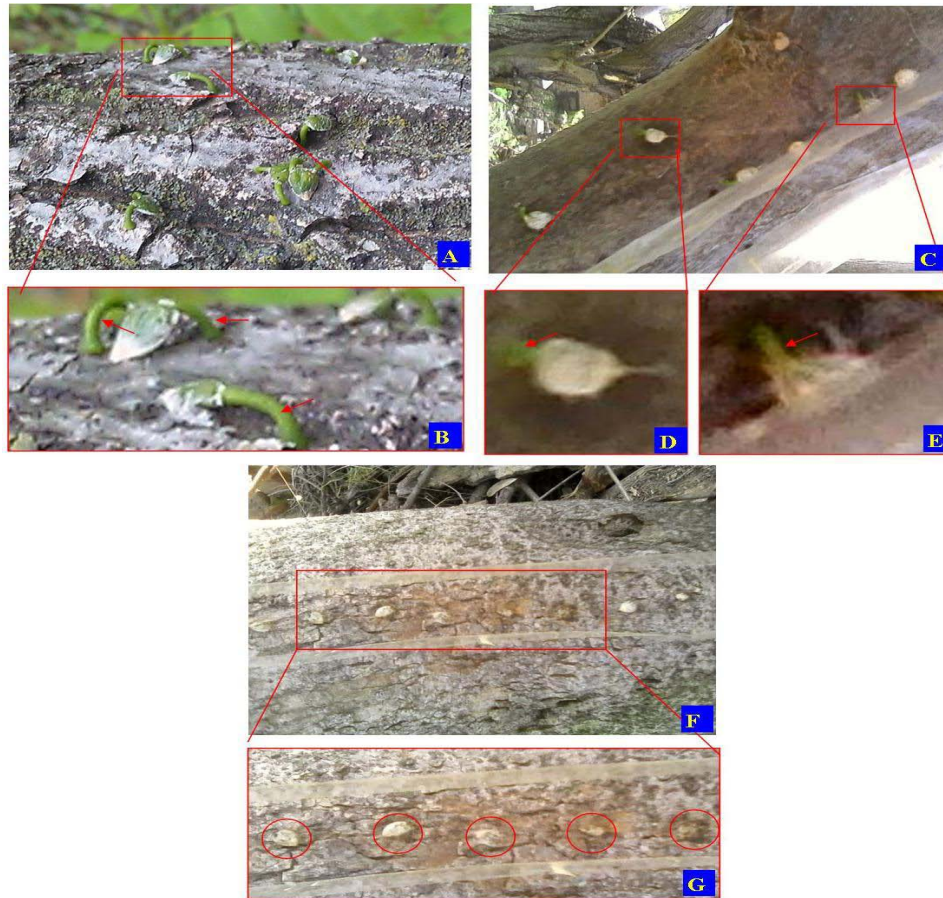


Figure 2: Geographical map showing the study area in northwest Himalaya, Jammu and Kashmir, India.

more appropriate as they provide the best platform in the fissures and grooves for the settlement of the seeds, e.g., *Juglans*, *Salix* and *Prunus*.

The exact stimulus for the germination of the seeds on a particular phorophyte is not clear, i.e., either controlled by the phorophyte itself or by environmental factors. In our experiment, as stated in the results the seeds of *V. album* germinates on six phorophytes viz. *Melia azedarach*, *Alnus nitida*, *Diaspyros lotus*, *Cedrus deodara*, *Olea cuspidata* and *Populus ciliata* and was not able to germinate and the rest two hosts i.e., *Quercus baloot* and *Ficus palmata*, indicates that the seeds of *V. album* do not germinate on all the tree species under same climatic condition and same geographical area (Table 3). Ethno-botanically the species is used to treat the hypertension [24]. In accordance with Musselman and Press, 1995, seed germination of parasitic plants is dependent upon the chemical signals from the host however we suggest that for establishment of the parasitic species, chemical signal studies are required to be conducted. Because, the seed germination in initial 60 days is observed as normal process however, establishment of the parasite even after 120 days of implantation has not been found in the study area under same climatic condition, where the *Viscum album* is reported infesting three tree species naturally.

Conclusion

Beside chemical signal from host species for germination of seeds of *V. album*, a chemical signal for establishment of the germinated

seeds may also be required from host plant, so that the parasite can establish on its host. Otherwise the germinated seeds cannot get established on host.

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