



## Research article

## Dhwaj sacred grove: A unique example of cultural beliefs and traditional conservation

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[Accepted: 17 September 2020]

**Abstract:** Sacred groves are well-protected areas managed by strong spiritual beliefs by the local communities and often represent the relict climax vegetation the region. The present study was conducted in Dhwaj sacred grove from the Central region of Indian Himalayas, releasing its role in biodiversity conservation through traditional and cultural belief systems. Total 81 species belonging to 67 genera and 50 families of plants were identified; in which 40 species were flowering plants, 23 species were lichens, 7 species bryophytes, 12 species were pteridophytes and only one species was gymnosperm. *Rhododendron arboreum* and *Quercus leuhotricophora* is the most dominant tree species in the grove showing highest IVI values. Ethnobotanically, 40 species belonging to 38 genera and 27 families are used by the local communities for the treatment of various ailments. But, due to high anthropogenic pressure, this grove facing several threat of degradation, hence special attention is needed towards its conservation and motivation to promote our traditional knowledge.

**Keywords:** Indian Himalayan Region - Sacred groves - Phytodiversity - Ethno-medicinal plants - Threat - Conservation.

[Cite as: Singh H & Kumar V (2020) Dhwaj sacred grove: A unique example of cultural beliefs and traditional conservation. *Tropical Plant Research* 7(3): 553–564]

### INTRODUCTION

A unique assemblage of flora and fauna in the Himalayan region makes it one of the important biodiversity hotspot on the Indian subcontinent. The people of this area have great affection to the nature and their indigenous knowledge of conserving ecosystem with great knowledge of sustainable utility are one of the factors which proof their close relationship with nature. This traditional knowledge enhances the respect towards spirituality and hence help in conservation (Vecsey 1980, Martinez 1996, Berkes 1999, Negi 2010, Ngbolua *et al.* 2016, Daba & Asfaw 2020).

Central Himalaya of India closely associated with many cultures, traditions, ethnic knowledge, folklores, etc. which is directly or indirectly affects the ecosystem. There were many traditional conservation practices of indigenous communities in many parts of the world, which contributed to the conservation of biodiversity. An excellent example of such traditional practices is the conservation of small or large patches by dedicating them to the local deities by various indigenous communities of the world. Such forest patches are called “sacred groves”. Sacred groves are the tracts of virgin forest that were left untouched by the local inhabitants, harbour rich biodiversity, and are protected by the local people due to their religious and cultural beliefs and taboos that the deities reside in them (Khan *et al.* 2008, Sukumaran *et al.* 2018). Sacred groves are the treasure house of natural vegetation and help in protection of society directly or indirectly (Schaaf 1998, Deepa *et al.* 2016). These groves often represent the relict climax vegetation with many rare and endangered species (Gadgil & Vartak 1975, Tiwari *et al.* 1999, Deepa *et al.* 2017). These groves are located in various altitudinal regions and hence, play a significant role in the conservation of rare and endangered species of the faunal and floral part (Mgumia & Oba 2003). All forms of vegetation in such a grove, including shrubs and climbers are supposed to be under the protection of the reigning deity of that grove, and the removal of even a small twig, is taboo

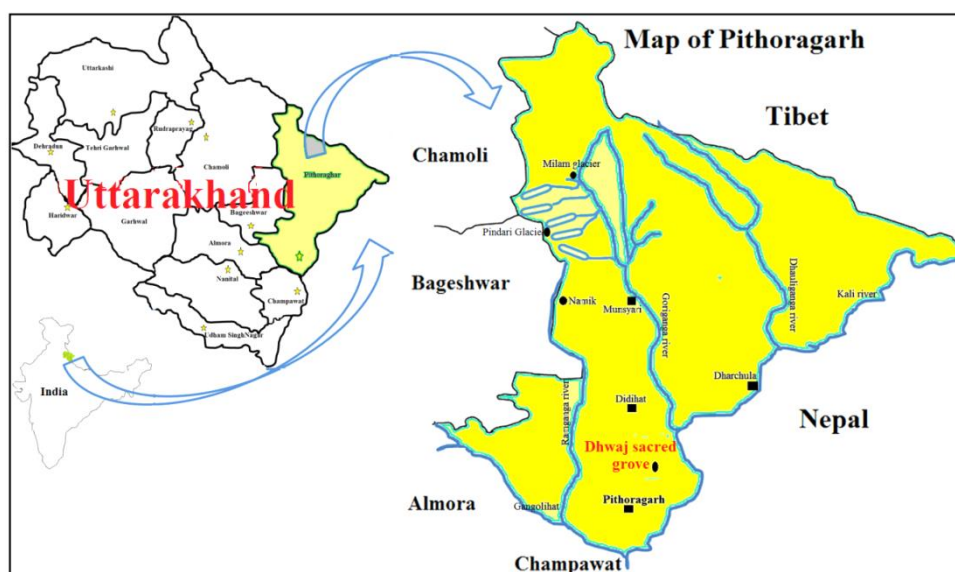
(Vartak & Gadgil 1973, Vartak 1983). These are the ancient natural forests where all forms of living creatures were afforded protection through the grace of some deity. These deities are generally of extremely primitive and fearsome nature and cutting or breaking even deadwood in a grove may result in a serious illness which has led in the protection of sacred forests in their virgin form. These groves have preserved the biological diversity of all level of that particular region which has vanished from other surrounding areas (Gadgil & Chandran 1992). Various studies are done throughout the world related to diversity and conservation of these groves and are named differently in various parts of India as *Kovil Kadu* in Karnataka, *Oran* in Rajasthan, *Law lyngdhoh* in Meghalaya, *Deovan* in Himachal Pradesh, *Saran* and *Deorai* in Madhya Pradesh, *Jaherthan* and *Garanthan* in West Bengal, *Ummanglai* in Manipur, *Devtha than* in Uttarakhand, etc. and are found in various habitats ranging from scrub forests of Thar desert maintained by Bishnois to Kerela in Western Ghats.

Many sacred groves are present in Garhwal and Kumaon Himalayan region with different cultures and traditions. Hariyali and Tarkeshwar sacred groves from Garhwal Himalaya are one of the important examples of biodiversity conservation by religious beliefs system of the Himalayan region (Sinha & Maikhuri 1998, Ghilidiyal *et al.* 2008). Various deities living in the groves namely Golu, Gangnath, Haat Kali, Bhumi Dev, Shyamju, Harju, Kotgari etc. and are responsible for the existence of these primitive and conserve patches or forests in the area. The study is lacking in Kumaon region of Indian Himalaya only Thalkedar, Nakuleshwar, Haat Kali, Chamunda Devi, Malay Nath, Patal Bhuvneshwar, Vaishneo Devi sacred groves were reported (Negi 2005, Agnihotri *et al.* 2009, Singh *et al.* 2010, Singh *et al.* 2012, Agnihotri *et al.* 2010, Singh *et al.* 2014). Mostly the study was concise in documentation and inventory, thus, realizing the importance of sacred groves in biodiversity conservation (Mehra *et al.* 2014). Thus a study was conducted in newly reported Dhvaj sacred grove which is present in Central Himalaya region of India and represents a rich biodiversity with many endemic and threatened species.

## MATERIALS AND METHODS

### Study area

Dhwaj sacred grove is situated near Totanula, near about 15 kms from the main Pithoragarh town on the route of Didihat (Figs.1, 2). It is a beautiful place with the luxuriant growth of both lower and higher plants; hence showing great phytodiversity. About 2 to 3 km from the road by foot at an altitude of 2366 m asl (29° 38' 48.62" N, 80° 17' 14.45") below the main temple, is situated the cave temple of Lord Shiva (*Baba Khandenath*) and tribute the whole grove to local deities *Jyanti Devi*. On enquiry with the local peoples we came to know that this sacred grove is about 600-700 years old and covering an area of 3.0 ha approximately. The monthly average of minimum and maximum temperature fluctuated throughout the year from 0°C to 18°C and 13°C to 25°C respectively. In January (and February season of winter), snow remains in this area for one or two days or sometimes for few hours. The broad leaves trees of *Quercus leucotrichophora* A. Camus and *Rhododendron arboreum* Sm. are dominant in this grove and support the luxuriant growth of vascular and non-vascular plants. From the hilltop where the deity *Jayanti Devi*, (a much feared Goddess in the area) temple is situated; from there the peaks of Panchachuli and Nanda Devi of Himalayas.



**Figure 1.** Location of study area in Pithoragarh district of Uttarakhand, India.



**Figure 2.** Dhwaj sacred grove covered by dense forest of *Quercus leucotrichophora* A. Camus and *Myrica esculenta* Buch.-Ham. ex D. Don trees.

#### Identification of the plant

Extensive field surveys were undertaken during 2008–2011 covering all the four seasons, viz. spring, rainy, summer and winter in the sacred grove. The existence of this grove was known from the local communities that reside in these areas. The different plant specimens were collected in the flowering and fruiting stage, or fertile stage in triplicate. Further, the specimens were processed as per standard herbarium techniques recommended (Jain & Rao 1977) and were deposited in LWG herbarium (herbarium at CSIR-National Botanical Research Institute), Lucknow. The specimens were identified based on morphological as well as micro-morphological characters and making use of different floras, monographs, revisions and other available literature (Osmaston 1927, Gupta 1968, Raizada & Saxena 1978, Naithani 1984, Gaur 1999, Awasthi 1991, 2007).

#### Species richness

For forest phytosociological study random stratified sampling 1 quadrates was used to assess ecological data in three forest layers (Greig-Smith 1983, Krebs 1989). Quadrates of 20 m × 20 m for tree species, 5 m × 5 m for shrub species and 1 m × 1 m for herb species were plotted to measure the frequency, density, abundance and species dominance since 1950 (Curtis & McIntosh 1950) Frequency, density, abundance & species dominance have been used to calculate the species Importance Value Index (IVI). Abundance and Frequency ratio (AF) for different species was determined for eliciting the distribution pattern in terms of regular (AF < 0.025), random (AF = 0.025–0.05) and contagious (AF > 0.05), as follows (Cottam & Curtis 1956).

## RESULTS

#### Diversity in the grove

This grove is a good example of biodiversity conservation and representing 81 species belonging to 67 genera and 50 families of both flowering and non-flowering plants (Table 1). Angiosperm were represented by 40 species belonging to 35 genera and 27 families in which herbaceous life form was dominant comprises both angiosperm (28 species) and pteridophytes (12 species) followed by shrubs (7 species) and trees (5 species) while 1 species of gymnosperm tree to the grove. In angiosperm, dominant family was Rosaceae with 5 species followed by Asteraceae (4 species), Rubiaceae (3 species), etc, while in pteridophyte, Polypodiaceae (4 species) and lichen Parmeliaceae (11 species).

**Table 1.** Phytodiversity of Dhwaj sacred groves.

S. No.	Botanical Name of Plants	Family	Habit (life form)
<b>Angiosperm</b>			
1.	<i>Anaphalis contorta</i> (D. Don.) Hook.f.	Asteraceae	Herb
2.	<i>Anaphalis margaritacea</i> (L.) Benth.	Asteraceae	Herb
3.	<i>Anaphalis triplinervis</i> (Sims) C.B. Clarke	Asteraceae	Herb
4.	<i>Berberis asiatica</i> Roxb. ex DC	Berberidaceae	Shrub
5.	<i>Berberis chitria</i> Lindl.	Berberidaceae	Shrub
6.	<i>Bergenia ciliata</i> (Haw.) Sternb.	Saxifragaceae	Herb
7.	<i>Bistortia amplexicaulis</i> (D. Don) Greene	Polygonaceae	Herb

8.	<i>Carpesium cernuum</i> L.	Asteraceae	Herb
9.	<i>Cyathula tomentosa</i> (Roth) Moq.	Acanthaceae	Herb
10.	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Herb
11.	<i>Dipsacus inermis</i> Wall.	Dipsacaceae	Herb
12.	<i>Duchesnea indica</i> (Andr.) Focke	Rosaceae	Herb
13.	<i>Erigerotis nigra</i> Nees ex Steud.	Apiaceae	Herb
14.	<i>Flemingia strobilifera</i> (L.) R. Br.	Fabaceae	Herb
15.	<i>Galium aparine</i> L.	Rubiaceae	Herb
16.	<i>Galium asperifolium</i> Wall. ex Roxb.	Rubiaceae	
17.	<i>Geranium wallichianum</i> D. Don ex Sweet.	Geraniaceae	Herb
18.	<i>Goldfussia dalhousiana</i> Nees	Acanthaceae	Herb
19.	<i>Goodyera hemasalyna</i> Nees	Orchidaceae	Herb
20.	<i>Hedychium spicatum</i> Sm.	Zingiberaceae	Herb
21.	<i>Impatiens balsamina</i> L.	Balsaminaceae	Herb
22.	<i>Myrica esculenta</i> Buch.-Ham. ex D. Don	Myricaceae	Tree
23.	<i>Oxalis corniculata</i> L.	Oxalidaceae	Herb
24.	<i>Prinsepia utilis</i> Royle	Rosaceae	Shrub
25.	<i>Pyracantha crenulata</i> (Roxb.) M. Roem.	Rosaceae	Shrub
26.	<i>Quercus leucotricophora</i> A. Camus	Fagaceae	Tree
27.	<i>Rhododendron arboreum</i> Sm.	Ericaceae	Tree
28.	<i>Rubia manjith</i> Roxb.	Rubiaceae	Climber
29.	<i>Rubus ellipticus</i> Smith	Rosaceae	Shrub
30.	<i>Rubus niveus</i> Thunb.	Rosaceae	Climber
31.	<i>Rumex hastatus</i> D. Don	Polygonaceae	Herb
32.	<i>Scutellaria scandens</i> Buch-Ham. ex D. Don	Lamiaceae	Herb
33.	<i>Smilax aspera</i> L.	Smilacaceae	Climber
34.	<i>Solanum nigrum</i> L.	Solanaceae	Herb
35.	<i>Swertia cordata</i> (G. Don) Wall. ex Clarke	Gentianaceae	Herb
36.	<i>Thalictrum foliolosum</i> DC.	Ranunculaceae	Herb
37.	<i>Valeriana jatamansi</i> Jones	Valeriaceae	Herb
38.	<i>Viburnum cotonifolium</i> D. Don	Capprifoliaceae	Tree
39.	<i>Viburnum mullah</i> Buch.-Ham. ex D. Don	Capprifoliaceae	Tree
40.	<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae	Shrub
<b>Gymnosperm</b>			
41.	<i>Cupressus tortolusa</i> D. Don	Cupressaceae	Tree
<b>Pteridophyte</b>			
42.	<i>Osmunda regalis</i> L.	Osmundaceae	Fern-allies
43.	<i>Adiantum venustum</i> D. Don	Adiantaceae	Fern
44.	<i>Adiantum lunulatum</i> Burm.	Adiantaceae	Fern
45.	<i>Lygodium flexuosum</i> (L.) Swartz	Lygodiaceae	Fern
46.	<i>Selaginella bryopteris</i> (L.) Bak.	Selaginellaceae	Fern-allies
47.	<i>Selaginella indica</i> (Milde) Trayon	Selaginellaceae	Fern-allies
48.	<i>Pyrrhosia flocculosa</i> (Don) Ching	Polypodiaceae	Fern
49.	<i>Oleandra wallichii</i> (Hook.) Presl.	Oleandraceae	Fern
50.	<i>Onychium lucidum</i> (Don.) Spr.	Cryptogrammeaceae	Fern
51.	<i>Drynaria mollis</i> Bedd.	Polypodiaceae	Fern-allies
52.	<i>Drynaria propinqua</i> (Wall. ex Mett.) Smith	Polypodiaceae	Fern-allies
53.	<i>Microsorium membranaceum</i> (D. Don) Ching	Polypodiaceae	Fern-allies
<b>Bryophyte</b>			
54.	<i>Bryosedgwickia aurea</i> (Schwaegr.) Fleisch.	Sematophyllaceae	Pleurocarpus
55.	<i>Campylopus goughii</i> (Mitt.) Jaeg.	Dicranaceae	Pleurocarpus
56.	<i>Marchantia paleacea</i> Bert.	Marchantiaceae	Pleurocarpus
57.	<i>Meteorium buchananii</i> (Brid.) Broth.	Meteoriaceae	Acrocarpous
58.	<i>Plagiochasma applendiculatum</i> Lehm et Lindenb	Aytoneaceae	Pleurocarpus
59.	<i>Thuidium assimile</i> (Mitt.) Jaeg.	Thuidiaceae	Acrocarpous
60.	<i>Trachypodopsis serrulata</i> (P. Beauv.) Fleisch.	Trachypodaceae	Pleurocarpus
<b>Lichen</b>			
61.	<i>Arthothelium abnorme</i> (Ach.) Müll.- Arg.	Arthoniaceae	Crustose
62.	<i>Bulbothrix isidiza</i> (Nyl.) Hale	Parmeliaceae	Foliose
63.	<i>Bulbothrix setschwanensis</i> (Zahlbr.) Hale	Parmeliaceae	Foliose
64.	<i>Canomaculina subtinctoria</i> (Zahlbr.) Elix	Parmeliaceae	Foliose
65.	<i>Canoparmelia eurperuta</i> (Mull.-Arg.) Elix & Hale	Parmeliaceae	Foliose

66.	<i>Cetrelia cetrarioides</i> (Del. ex Duby) W. Culb. & C. Culb	Parmeliaceae	Foliose
67.	<i>Chrysothrix chlorine</i> (Ach.) Laundon	Chrysothricaceae	Crustose
68.	<i>Graphis hossei</i> Vainio	Graphidaceae	Crustose
69.	<i>Heterodermia albidiflava</i> (Kurok.) Awasthi	Physciaceae	Foliose
70.	<i>Heterodermia diademata</i> (Taylor) Awasthi	Physciaceae	Foliose
71.	<i>Hypotrachyna flexilis</i> (Kurok.) Hale	Parmeliaceae	Foliose
72.	<i>Lecanora achaoa</i> Nyl.	Lecanoraceae	Crustose
73.	<i>Lecanora japonica</i> Müll. Arg.	Lecanoraceae	Crustose
74.	<i>Parmotrema praesorediosum</i> (Nyl.) Hale	Parmeliaceae	Foliose
75.	<i>Parmotrema austrosinensis</i> (Zahlbr.) Hale	Parmeliaceae	Foliose
76.	<i>Parmotrema ultraleucens</i> (Krog) Hale	Parmeliaceae	Foliose
77.	<i>Pertusaria melastomella</i> Nyl.	Pertusariaceae	Crustose
78.	<i>Pertusaria rigida</i> Müll. Arg.	Pertusariaceae	Crustose
79.	<i>Punctelia rudecta</i> (Ach.) Krog. Nord.	Parmeliaceae	Foliose
80.	<i>Ramalina conduplicans</i> Vain.	Ramaliaceae	Fruticose
81.	<i>Usnea pseudosinensis</i> Asahina	Parmeliaceae	Fruticose

#### Species composition and distribution

This sacred grove is covered by dense forest canopy of *Rhododendron arboreum* Sm. and *Quercus leucotrichophora* A. Camus trees representing moist sub-temperate type forest. *Rhododendron arboreum* Sm. was found to be the most dominant tree species representing highest density (55) and Importance Value Index (IVI) (69.77926) followed by *Quercus leucotrichophora* A. Camus, *Myrica esculenta* Buch.-Ham. ex D. Don, *Cupressus tortolusa* Griff., etc (Table 2; Fig. 3). Some herbaceous species viz., *Dipsacus inermis* Wall., *Goodyera hemsleyana* King & Pantl., *Lygodium flexuosum* (L.) Sw. are found regularly with high AF value while some are with low AF values. Herbaceous plant species are regularly or randomly distributed all along the grove in which *Pyrrosia flocculosa* (D. Don) Ching (fern) was found to be the most dominant species with highest density and IVI followed by angiospermic plant species such as *Goldfussia dalhousiana* Nees, *Duchesnea indica* (Jacks.) Focke, *Bergenia ciliata* (Haw.) Sternb., etc. According to A/F value, most of the plant species are distributed regularly of 51% while some are 26% randomly and 23% species were contagiously distributed. Regular distribution of species at study site was almost negligible in case of tree and shrub while 100% shrub species contagiously distributed.

**Table 2.** List of ethno-medicinal plants used by the local community of Dhvaj sacred grove.

S.No.	Scientific Name	Family	Local Name	Part used	Ethno-medicinal Uses
1.	<i>Anaphalis margaritacea</i> (L.) Benth.	Asteraceae	-	Whole plant	Cold and cough
2.	<i>Berberis asiatica</i> Roxb. ex DC	Berberidaceae	Kilmora	Root/Stem	Fever, diabetes
3.	<i>Berberis chitria</i> Ham. ex Ker.	Berberidaceae	Kingore	Root/Stem/Fruits	Fever, stomach problem
4.	<i>Bergenia ciliata</i> (Haw.) Sternb.	Saxifragaceae	Patarcattha/pat archur	Rhizome	Kidney stone, tonic
5.	<i>Cyathula tomentosa</i> Miq.	Acanthaceae	Letkura/Katari	Leaves	Skin diseases
6.	<i>Cynadon dactylon</i> (L.) Pers.	Poaceae	Doob	Whole plant	Fever, tonic
7.	<i>Eragrotis nigra</i> Nees ex Steud.	Poaceae	-	Root	Tonic
8.	<i>Flemingia strobilifera</i> (L.) R. Br.	Fabaceae	Salpani/Bhadu la	Whole plant	Fever, bronchial problem
9.	<i>Galium aparine</i> L.	Rubiaceae	-	Root/stem	Tonic
10.	<i>Geranium wallichianum</i> D. Don ex Sw.	Geraniaceae	Bhanda/Bheel-jadhi	Whole plant	Fever, liver problem
11.	<i>Hedychium spicatum</i> Buch.-Ham. ex Sm.	Zingiberaceae	Van haldu	Rhizome	Cold, cough, tonic, asthma, gastric problem, liver diseases, fever.
12.	<i>Myrica esculenta</i> Buch.-Ham. ex D. Don	Myricaceae	Kaphal	Fruits & stem bark	Stomach problem
13.	<i>Oxalis corniculata</i> L.	Oxalidaceae	Chilmori	Whole plant	Piles
14.	<i>Bistorta amplexicaulis</i> (D. Don) Greene	Polygonaceae	Kutrya	Root	Tonic, cough
15.	<i>Prinsepia utilis</i> Royle	Rosaceae	Bhekal	Seeds	Skin disease
16.	<i>Pyracantha crenulata</i> (D. Don) Roem.	Rosaceae	Ghingaroo	Fruits	Stomach disorder

17.	<i>Quercus leucotrichophora</i> A. Camus	Fagaceae	Banj	Fruit, gum & Stem bark	Energy enhancer, tonic, fever
18.	<i>Rhododendron arboreum</i> Sm.	Ericaceae	Buras	Flower & Stem Bark	Blood purifier,
19.	<i>Rubia manjith</i> Roxb. ex Fleming	Rubiaceae	Manjitt/Khudera	Root	Dysentery, fever, tonic
20.	<i>Rubus ellipticus</i> Sm.	Rosaceae	Hisaloo	Root	Stomach problem
21.	<i>Rubus niveus</i> Thunb.	Rosaceae	Kala hisaloo	Fruit & root	Stomach disorder
22.	<i>Rumex hastatus</i> D. Don	Polygonaceae	Chilmori	Whole plant	Stomach problem
23.	<i>Solanum nigrum</i> L.	Solanaceae	Makoi	Fruit	Liver disorder, diarrhoea
24.	<i>Swertia cordata</i> (Wall. ex G. Don) C.B. Clarke	Gentianaceae	Chirata	Whole plant	Fever, cold, tonic
25.	<i>Taraxacum officinalae</i> Weber	Asteraceae	Kanphul	Root	Kidney disorder, Stomach problem
26.	<i>Viburnum cotinifolium</i> D. Don	Capprifoliaceae	Ghinua	Stem bark & fruit	Hepatic disorder
27.	<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae	Bichooghas	Aerial part	Swelling, skin diseases
<b>Lichens</b>					
28.	<i>Parmotrema reticulatum</i> (Taylor) M. Choisy	Parmeliaceae	Jhulla	Thallus part	Cough, cold
29.	<i>Flavoparmelia caperata</i> (L.) Hale	Parmeliaceae			Cough
30.	<i>Cetrelia cetrarioides</i> (Delise in Dub.) W.L. Culb & C.F. Culb.	Parmeliaceae	Jhulla/charilla	Thallus part	Cough, fever
31.	<i>Ramalina conduplicans</i> Vain.	Ramalinaceae	Jhulla	Thallus part	Cold and cough
32.	<i>Usnea pseudosinensis</i> Asahina	Parmeliaceae	Jhulla	Thallus part	Throat infection, fever
<b>Gymnosperms</b>					
33.	<i>Cupressus tortulosa</i> D. Don	Cupressaceae	Surai	Leaves oil	Whooping cough
<b>Pteridophytes</b>					
34.	<i>Osmunda regalis</i> L.	Osmundaceae			Jaundice
35.	<i>Adiantum lunulatum</i> Burm.	Adiantaceae	Dun-sink	Whole plant	Cough, cold, throat infection, fever
36.	<i>Adiantum venustum</i> D. Don	Adiantaceae	KaloHansraj	Whole plant	Cough, cold and fever
37.	<i>Selaginella bryopteris</i> (L.) Baker	Selaginelaceae	Sanjevanii	Whole plant	Jaundice
<b>Bryophytes</b>					
38.	<i>Thuidium assimile</i> (Mitt.) Jaeg.	Thuidiaceae	-	Whole plant	Wounds
39.	<i>Meterorium buchananii</i> (Brid.) Broth.	Meteoriaceae	-	Whole plant	Cut and wounds
40.	<i>Plagiochasma appendiculatum</i> Lehm et Lindenb	Aytoneaceae	-	Whole plant	Wound

#### Ethno-medicinal plants

For the collection data related to ethno-medicinal plants, 16 persons are interviewed out of which 10 informants (7 males and 3 females) are respondent. The other informants have keep their medicinal plant knowledge secret and formally transferred along the family line *i.e.*, from father/mother to child mainly a son.

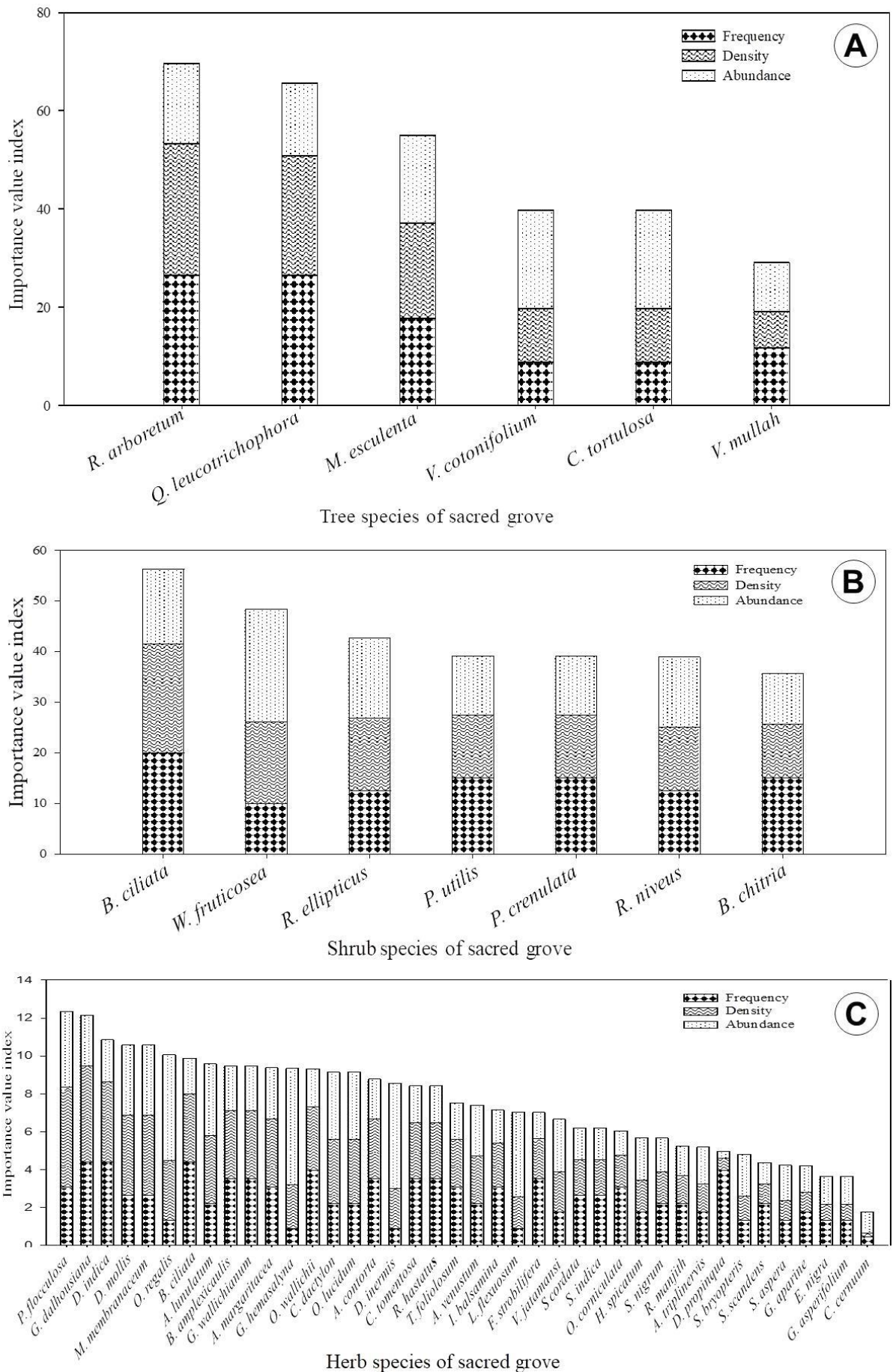
A total 40 ethno-medicinal plants, angiosperm represents 27 species belonging to 26 genera and 19 families, 1 species in 1 genus and 1 family of gymnosperm, 4 species in 3 genera and 3 families of pteridophyte, 3 species under 3 genera and 3 families of bryophytes and 5 species under 5 genera and 1 family of lichen were reported and used in various ailments (Table 3).

**Table 3.** List of RET taxa present in the grove.

S. No.	Scientific Plant Name	Family	Status
1.	<i>Valeriana jatamansi</i> Jones	Valerianaceae	Vulnerable
2.	<i>Bergenia ciliata</i> (Haw.) Sternb.	Saxifragaceae	Vulnerable
3.	<i>Berberis asiatica</i> Roxb. ex DC.	Berberidaceae	Critically endangered
4.	<i>Hedychium spicatum</i> Sm.	Zingiberaceae	Vulnerable
5.	<i>Swertia cordata</i> (Wall. ex G. Don) C.B. Clarke	Gentianaceae	Vulnerable
6.	<i>Goodyera hemsleyana</i> King & Pantl.	Orchidaceae	Critically endangered
7.	<i>Myrica esculenta</i> Buch.-Ham. ex D. Don	Myricaceae	Vulnerable
8.	<i>Osmunda regalis</i> L.	Osmundaceae	Threatened

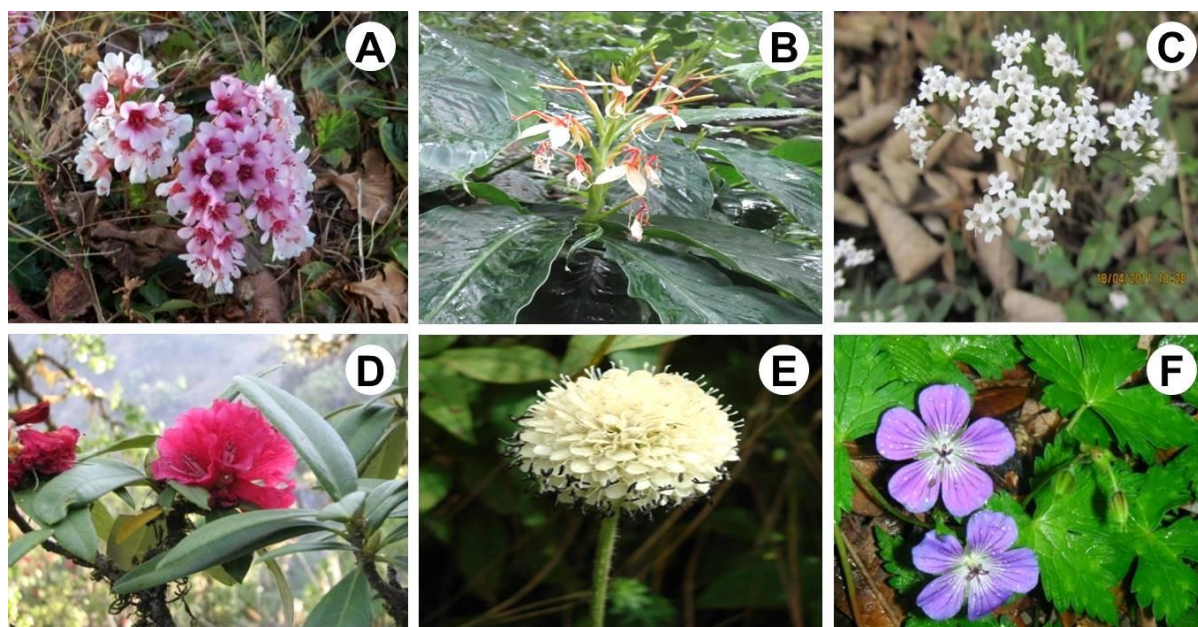
#### Associated plant species

Trees like *Rhododendron arboreum* Sm., *Quercus leucotrichophora* A. Camus, *Myrica esculenta* Buch.-



**Figure 3.** Showing various life forms in the Dhvaj sacred grove with their frequency, density and abundance: **A**, Tree species of sacred grove; **B**, Shrub species of sacred grove; **C**, Herb species of sacred grove.

Ham. ex D. Don, *Viburnum cotinifolium* D. Don and *Viburnum mullaha* Buch.-Ham. ex D. Don makes dense canopy inside the grove and providing shelter to many shade loving plants. *Rhododendron arboreum* Sm., *Dipsacus inermis* Wall., *Bergenia ciliata* (Haw.) Sternb. and *Geranium wallichianum* D. Don ex Sweet are the most beautiful flowers bearing plants during the flowering seasons (February to October) in the grove (Fig. 4). Phytodiversity includes all life and growth forms (both lower and higher plant species), which are playing pivotal role in balancing any ecosystem. Plant like *Goodyera hemsleyana* King & Pantl., *Bergenia ciliata* (Haw.) Sternb., *Valeriana jatamansi* Jones, *Hedychium spicatum* Sm. (Angiosperm); *Adiantum venustum* D. Don, *Lygodium flexuosum* (L.) Sw. (Pteridophyte); *Bryosedgwickia aurea* (Schwagr.) M. Fleisch., *Campylopus goughii* (Mitt.) A. Jaeger (Bryophytes); and *Punctelia rudecta* (Ach) Krog (Lichens) need humus rich soil, moist conditions, optimum temperature (15–25°C) and sufficient light for their luxuriant growth and all these micro-climatic conditions available in this sacred grove. Occurrence of *Bistoria amplexicaulis* (D. Don) Greene, *Valeriana jatamansi* Jones, *Swertia cordata* (Wall. ex G. Don) C. B. Clarke, *Bergenia ciliata* (Haw.) Sternb., *Goodyera hemsleyana* King & Pantl., *Hedychium spicatum* Sm., etc. indicates the good micro-climatic conditions in the grove. Climbers, *Smilax aspera* L., *Galium asperifolium* Wall. and *Rubia manjith* Roxb. ex Fleming are hanging in different substratum of trees and shrubs. A parasitic plant species *Cuscuta reflexa* Roxb. is climbing on *Pyracantha crenulata* (Roxb. ex D. Don) M. Roem. and *Berberis asiatica* Roxb. ex DC. which is also contributing unique habitat for phytodiversity of the grove.



**Figure 4.** Beautiful flowers of the sacred grove: **A**, *Bergenia ciliata* (Haw.) Sternb.; **B**, *Hedychium spicatum* Sm; **C**, *Valeriana jatamansi* Jones; **D**, *Rhododendron arboreum* Sm; **E**, *Dipsacus inermis* Wall.; **F**, *Geranium wallichianum* D. Don ex Sweet.

Creteaceous shrubs, *Berberis asiatica* Roxb. ex DC. and *Pyracantha crenulata* (Roxb. ex D. Don) M. Roem. provides excellent substratum for epiphytic lichens and mosses. Lichen like *Usnea pseudosinensis* Asahina and *Ramalina conduplicans* Vain. are growing epiphytically on branches of *Pyracantha crenulata* (Roxb. ex D. Don) M. Roem., *Berberis asiatica* Roxb. ex DC., etc. *Canoparmelia caperata* (Mull. Arg.) Elix & Hale and *Cetrelia cetrarioides* (Duby) W. Culb. & C. Culb. are mostly growing on the substratum of *Rhododendron arboreum* Sm. and *Quercus leucotrichophora* A. Camus. Bryophytes like *Marchantia paleacea* Bertol. and *Plagiochasma appendiculatum* Lehm & Lindenb. are growing on moist rock. Pteridophytes like *Adiantum venustum* D. Don, *A. lunulatum* Burm. f., *Osmunda regalis* (L.), *Selaginella bryopteris* (L.) Baker, are found on the moist rocks along the water reservoir. *Pyrrosia flocculosa* (D. Don) Ching and *Drynaria mollis* Bedd. are found epiphytically on the bark and branches of *Quercus leucotrichophora* A. Camus.

#### Traditional beliefs

In this sacred grove, the local community is much feared to the deity ‘*Maa Jyanti*’. The deity of the grove is very ferocious and all forms of vegetation in such a sacred grove are under the protection of the reigning deity of that grove, and the removal, even of deadwood, is taboo. These strong traditional beliefs can help to conserve the biodiversity of the area day by day with the fear of deity reside in them. The villagers would not dare to enter this forest for fear of angering the resident deity. In this way, these habitats are more sensitive to the



effects of modification than others, and hence avoidance or mitigation of such habitat change can be a form of conservation.

#### *Cultures and folk taboos in the sacred grove*

- A. The whole grove is governing by the local customs used by the surrounding communities and nearby villagers.
- B. Collection of fuel, fodder is strictly prohibited, even a falling twigs and leaves on the ground of these sacred patches. Only certain cases, the villagers enter in these groves on the occasions of annual festivals.
- C. Women are strictly prohibited from entering sacred forest during menstrual cycle and pregnancy.
- D. The lower castes are debarred to enter the sacred forests, only by the permission of the local authorities.
- E. Before entering in sacred groves, the people stop taking onion, garlic, egg and meat.

#### DISCUSSION

Dhwaj sacred grove is a good example of strong traditional beliefs and taboos by the local people to conserve biodiversity. This grove is present at an altitude of 2200 m and a treasure house of many threatened flora of the Himalayan region. The grove has a high number of species in a small area similar studies are also seen in the same region (Agnihotri *et al.* 2009, Sukumaran *et al.* 2018), In angiosperm, the dominant family was Rosaceae followed by Asteraceae, Rubiaceae, etc, while in pteridophyte, Polypodiaceae and in lichen Parmeliaceae, etc. which represents the good environment of the grove. Among the 81 species, *Bergenia ciliata* (Haw.) Sternb., *Berberis asiatica* Roxb. ex DC., *Hedychium spicatum* Sm, *Swertia cordata* (Wall. ex G. Don) C. B. Clarke and *Valeriana jatamansi* Jones are some potential threatened medicinal and aromatic plants in the grove (Sammant *et al.* 1998, Arya & Agarwal 2006).

For ethnobotanical studies, the majority of the informants reported that they keep their medicinal plant knowledge secret and formally transferred along the family line *i.e.* from father/mother to child mainly a son also reported by other researchers (Sharma *et al.* 1992, Gedif & Hahn, 2002, Uniyal *et al.* 2006, Panghal *et al.* 2010, Bajpai *et al.* 2016, Gadhvi & Modi 2019, Ahmed *et al.* 2020).

Presence of water in the grove is due the dense forest of *Quercus leucotrichophora* A. Camus (Adhikari & Adhikari 2007) which is responsible for luxuriant growth of *Adiantum venustum* D. Don, *A. lunulatum* Burm., etc. and other water-loving plants. Lichens are the bio-indicator and presence of certain lichens indicates the forest type of the region *viz.*, luxuriant growth of *Usnea pseudosinensis* Asahina, *Ramalina conduplicans* Vain. and *Lobaria retigera* (Bory) Trevis. in the grove represents the presence of smooth barked trees and evergreen forest type where the environment is fresh while the presence of *Lecanora achaoa* Nyl., *Lecanora japonica* Müll. Arg. represent the well illuminated environmental conditions in the grove (Singh & Husain 2012). Due to presence of dense canopy of *Rhododendron arboreum* Sm. which was found most dominant tree species representing highest density and IVI 69.77926 followed by *Quercus leucotrichophora* A. Camus, *Myrica esculenta* Buch.-Ham. ex D. Don, etc which is represented moist and temperate type forest which was also matched with other studies. Fern-like *Pyrrosia flocculosa* (D. Don) Ching was found to be the most dominant herbaceous species with highest density and IVI in the grove showing their dense presence in such environment.

The deity of the grove is very ferocious in nature and all forms of vegetation in such a sacred grove are under the protection of the reigning deity and the removal, even of deadwood, is taboo (Singh *et al.* 2010).

#### CONCLUSIONS

The exclusive taxa are found refuge in the micro-climatic conditions of the grove, which does not only connect the species to the ecosystem but also related to socio-cultural aspects which result conserved and reservoir of biodiversity. The case of Dhwaj sacred grove shows that it is functioning as a rich storehouse of bio-diversity and is managed by local communities which preserve their natural forest for the future generation. Indian Himalaya is a place of god with varied sacred groves maintained by different tribal and non-tribal communities having many rare and endangered flora and fauna. Loss of such grove adversely affects the environment and consequently, imbalance our ecological balance. Many plant species are endemic and threatened to this grove only, it is essential that this grove immediately brought under protected area network to ensure the protection of such plants and animals and their habitat. Management of existing village and community forests may be improved through adequate funding to village durbars and through appropriate management interventions by the government using a participatory approach. This will help in meeting the biomass needs of the villagers, which in turn will reduce the anthropogenic pressures on sacred groves. Nursery techniques, both *ex-situ* and *in-situ* conservation and management must be taken for the native and threatened

species that are confined to sacred groves and such species should be planted in nearby village reserve forests and in the degraded sacred grove areas. There is a need to convert the traditional beliefs of the tribal people into effective conservation values behind the beliefs that need to be explained to the villagers. The only occasion these areas are accessed, with minimal invasion, is during annual Dhwaj festival in August. Tourism, collection of medicinal plants, fire, fuel, fodder and grazing are some anthropogenic pressures which are causing a serious threat to the rich forest of Dhwaj sacred grove.

#### ACKNOWLEDGEMENTS

Authors are grateful to the Director of CSIR-National Botanical Research Institute, Lucknow, for facilities. The authors also thankful to lichenologist Dr. D.K. Upreti and Dr. A.K. Asthana, CSIR-NBRI, Lucknow for help in identifying lichens and bryophytes. Finally, to the local communities whose support was impressive during collecting indigenous knowledge and plants.

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