

<https://doi.org/10.53032/tvcr/2022.v4n4.03>

Research Article

Assessment of Ecological Variation and Distribution Patterns of Pteridophytes in Hokra and its Adjoining Region of Indian Central Himalaya

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ABSTRACT

Pteridophytes constitute one of the major groups of the plant kingdom and contribute significantly to the biodiversity of Himalayan ecosystems. Their occurrence and distribution are strongly influenced by environmental variables, including moisture availability, light penetration, topographical variation, altitudinal gradients, and specific microhabitat conditions. Therefore, the objective of the present study is to assess variations in the ecological characteristics and distribution patterns of pteridophytes in the study area, with particular emphasis on their habitat preferences, substratum preferences, altitudinal distribution, and moisture requirements.

Keywords: Biodiversity, Pteridophytes, Environmental variables, Seed plants

INTRODUCTION

Himalayan Region is one of the 34 biodiversity hotspots recognized worldwide, which is a profoundly rich and irreplaceable source of biological diversity (Sharma, 2013). It is world famous for its unique topography of complex mosaic of deep valleys and high peaks, wide range of altitude, varied climatic habitats and a large network of life supporting rivers and

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streams (Sharma, 2013). These distinctive geographical and environmental features synergistically support a rich and dynamic spectrum of unique species, biological communities and complex ecosystems (Samant et al., 1998; Singh, 2006)

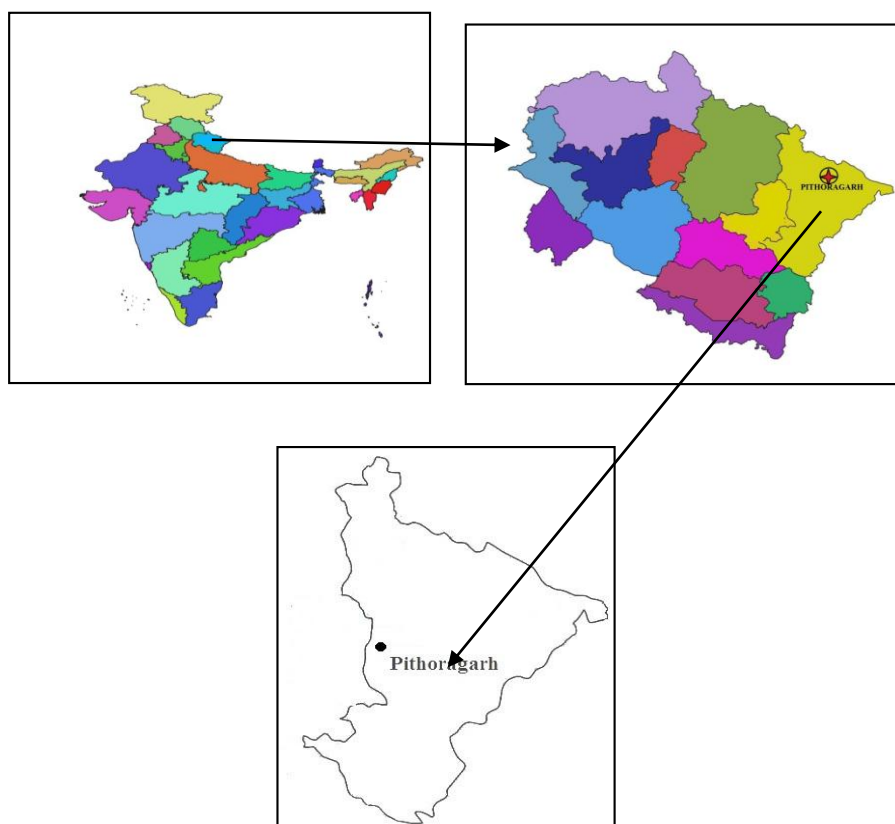
Pteridophytes, including ferns and fern allies, are important components of plant diversity in shaded, humid, and mountainous ecosystems. Their presence, growth, and development are strongly influenced by various environmental variables, including moisture availability, light intensity, substrate characteristics, soil properties, and nutrient availability. These environmental variables play a crucial role in determining the distribution, abundance, and diversity of pteridophytes across different habitats.

Unlike many seed plants, several fern species exhibit specific microhabitat requirements. They may occur as terrestrial plants on soil and forest floors, as epiphytes on the trunks and branches of trees, or as lithophytes growing on rocks and other rocky substrates. Altitude is another important factor influencing the distribution and composition of ferns and fern allies, particularly in mountainous ecosystems. Similarly, moisture availability is a critical ecological variable that determines their establishment, growth, and distribution.

MATERIAL AND METHODS

Study area

The present study was carried out in Hokra and adjoining region (Namik) of Talla Johar valley of Munshyari Taluka of Pithoragarh District of Uttarakhand, India.



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Fig 1. Showing the location of Study area

Survey and Data collection

The study area was surveyed during 2020–2021, particularly during the rainy season. Plant specimens were collected from their natural habitats, ensuring that healthy plants with all essential parts were selected. Two specimens of each species were collected. Herbarium specimens of the collected plants were prepared following the standard herbarium techniques described by Jain and Rao (1977). Relevant data, including the habit and habitat of ferns, their GPS coordinates, and altitude, were recorded. Photographs of the specimens were also taken using a DSLR camera for the identification and authentication of ferns and fern allies. The collected specimens were identified using relevant literature, research papers, and regional floras (Kholia, 1992; Khullar, 1994, 2000; Pande and Pande, 2003; Fraser-Jenkins, 2015). For classification, the system proposed by Fraser-Jenkins (2020) was followed.

RESULTS AND DISCUSSION

A total number of 40 ferns and ferns allies were collected from study area. Their habitat preference, Distribution of species across different altitudinal zones, their preference for moisture and substratum were also analyzed. The analysis of the result of their habitat preference shows that majority of ferns species were terrestrial with few being epiphytes and lithophytes, the distribution pattern of ferns and ferns allies shows that majority of them are found altitude zone between Lower Zone (1,450–1,850 m / Hokra) and Mid-Lower Zone (1,800–2,200 m / Namik). It was also found that majority of ferns preferring moist and shaded places and showing their luxuriant growth there. Similarly majority of epiphytes are found to grow in tree trunk and branches with only a single species found to reaching canopy. It was also found lithophytes were found to grow in two types of rocky substratum with Dry and Barren Rocks another were damp and shaded rocks

Distribution of species across different altitudinal zones in association with higher plants in study area

Lower Zone (1,450–1,850 m / Hokra)

This zone is the sub-tropical to lower temperate transition ecozone. The forest vegetation is dominated by Banj oak (*Quercus leucotrichophora*) and associated higher plant species like *Alnus nepalensis*, *Aesculus indica*, *Lyonia ovalifolia* and *Rhododendron arboreum*. The Hokra locality is important because it has a sacred grove, protected by local traditional conservation practices, which has maintained relatively pristine conditions of forest favorable for pteridophyte diversity.

Some of the common species of this zone including *Adiantum capillus-veneris* L. *Aleuritopteris bicolor* (Roxb.) Griff. ex Fras.-Jenk; *Botrychium lanuginosum* (Wall. ex Hook. & Grev.) Holub.; *Diplazium esculentum* (Retz.) Sw; *Microsorium membranaceum* (D. Don) Ching; *Onychium cryptogrammoides* Christ.; *Pteris vittata* L.; *Lepisorus nudus* (Hook.) Ching; *Polystichum squarrosum* (D. Don) Fée; *Oleandra wallichii* (Hook.) C. Presl etc.

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Mid-Lower Zone (1,800–2,200 m / Namik)

This zone supports high diversity of pteridophytes due to favorable moisture conditions, moderate temperatures, and the presence of sacred grove protection maintaining forest integrity. This zone is characterized by mixed oak-pine forests with higher canopy cover, creating favourable conditions for epiphytic and terrestrial ferns. The Namik locality's proximity to the Namik Glacier ensures consistent moisture availability through glacial runoff. Higher plant associates include *Pinus roxburghii*, *Quercus leucotrichophora*, and *Rhododendron arboreum*. Several fern species show transitional patterns, occurring in both the lower and mid-lower zones, indicating their ecological plasticity across altitudinal boundaries. Some of the common species of this zone including *Adiantum capillus-veneris* L.; *Polystichum discretum* (D. Don) J. Sm.; *Polystichum nepalense* (Speng.) C. Chr.; *Polystichum mehrae* Fras.-Jenk. & Khullar; *Pteridium revolutum* (Blume) Nakai; *Pteris cretica* L.; *Pteris vittata* L.; *Pteris biaurita* L.; *Pteris wallichiana* J. Agardh; *Woodwardia unigemmata* (Mak.) Nakai; *Pyrrosia flocculosa* (D. Don.) Ching; *Woodsia elongata* Hook.; *Pichisermollodes ebenipes* (Hook.) Fraser-Jenk.; *Pichisermollodes stewartii* (Bedd.) Fraser-Jenk. etc

Upper Zone (2,600–3,073 m / Thala)

As elevation increases to Thala, the flora becomes progressively more specialized to cold, high-altitude conditions. Tree species dominating this zone include *Betula utilis*, *Rhododendron campanulatum*, *Quercus semicarpifolia*, and *Taxus baccata*. Pteridophyte occurrence decreases significantly at these elevations due to harsh climatic conditions, shorter growing seasons, and reduced moisture availability.

Some common species of this area including: *Coniogramme intermedia* var. *glabra* Ching; *Drynaria mollis* Bedd.; *Dryopteris juxtaopposita* Christ.; *Polystichum mehrae* Fras.-Jenk. & Khullar; *Polypodiodes amoena* (Wall ex Mett.) Ching; *Pichisermollodes malacodon* (Hook.) Fraser-Jenk.etc.

Habitat preferences of ferns and ferns allies of study area

Pteridophytes are an enigmatic group within the plant kingdom. They exhibit diverse habitat preferences and can grow as terrestrial plants on soil, forest floors, and open lands. Some species are epiphytic, growing on the trunks and branches of other plants, while others are lithophytic, growing on rocks and other rocky substrates. Based on their habitat preferences, pteridophytes can be categorized into the following groups, as listed in the table below

Terrestrial pteridophytes of study area

S. no.	Plant species	Habitat
1.	<i>Lycopodium japonicum</i> Thunb.	Terrestrial
2.	<i>Selaginella chrysocaulos</i> (Hook. and Grev.)	Terrestrial

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3.	<i>Equisetum arvense</i> Linn.	Terrestrial
4.	<i>Equisetum diffusum</i> D.Don	Terrestrial
5.	<i>Botrychium lanuginosum</i> Wall. ex Hook. & Grev.	Terrestrial
6.	<i>Ophioglossum reticulatum</i> L.	Terrestrial
7.	<i>Osmunda claytoniana</i> Linn.	Terrestrial
8.	<i>Dennstaedtia appendiculata</i> (Wall. Ex Hook.)	Terrestrial
9.	<i>Odontosoria chinensis</i> (L.)	Terrestrial
10.	<i>Adiantum incisum</i> Forssk.	Terrestrial
11.	<i>Adiantum venustum</i> D.Don.	Terrestrial
12.	<i>Aleuritopteris bicolor</i> (Roxb.)	Terrestrial
13.	<i>Onychium cryptogrammoides</i> Christ	Terrestrial
14.	<i>Onychium lucidum</i> (D.Don.) Spreng	Terrestrial
15.	<i>Pteris aspercaulis</i> Wall.ex Ag.	Terrestrial
16.	<i>Pteris cretica</i> L.	Terrestrial
17.	<i>Pteris wallichiana</i> J. Agardh	Terrestrial
18.	<i>Pteris vittata</i> L.	Terrestrial
19.	<i>Athyrium atkinsonii</i> Bedd.	Terrestrial
20.	<i>Deparia japonica</i> (Thun. ex Murray) Kato.	Terrestrial
21.	<i>Diplazium esculentum</i> (Retz.) Swartz.	Terrestrial
22.	<i>Woodwardia unigemmata</i> (Makino) Nakai	Terrestrial

Epiphytic ferns of study area

S. no.	Plant species	Habitat
1.	<i>Ketoella pulchra</i> (D.Don) M.Kato & Tsutsumi	Epiphytes
2.	<i>Drynaria mollis</i> Bedd.	Epiphytes
3.	<i>Drynaria propinqua</i> (Wall. ex Mett.) J.Sm.,	Epiphytes
4.	<i>Lepisorus morrisonensis</i> (Hayata) H. Ito	Epiphytes
5.	<i>Loxogramme porcata</i> Price,	Epiphytes
6.	<i>Pichisermollodes ebenipes</i> (Hook.)	Epiphytes

Lithophytic ferns of study area

S. no.	Plant species	Habitat
1	<i>Asplenium dalhousiae</i> Hook.,	Lithophytes
2	<i>Arthromeris wallichiana</i> (Spreng.) Ching	Lithophytes
3	<i>Lepisorus bicolor</i> (Takeda) Ching	Lithophytes

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4	<i>Pichisermollodes malacodon</i> (Hook.) Fraser-Jenk.	Lithophytes
5.	<i>Polypodiodes amoena</i> (Wall ex Mett.) Ching	Lithophytes

Ferns that grows more than one habitat

S. no.	Plant species	Habitat
1.	<i>Selaginella subdiaphana</i> (Wall. ex Hook. & Grev.)	Terrestrial; Lithophytes
2.	<i>Adiantum capillus-veneris</i> (L.)	Terrestrial; Lithophytes
3.	<i>Vittaria himalayensis</i> Ching,	Epiphytes; Lithophytes
4.	<i>Oleandra wallichii</i> (Hook.) C.Presl.	Terrestrial; Epiphytes; Lithophytes
5.	<i>Lepisorus mehrae</i> Fraser-Jenk.,	Epiphytes; Lithophytes
6.	<i>Lepisorus nudus</i> (Hook.) Ching	Epiphytes; Lithophytes
7.	<i>Microsorium membranaceum</i> (D.Don).	Epiphytes; Lithophytes
8.	<i>Polypodiodes lechnopus</i> (Wall ex Hook) Ching.	Epiphytes; Lithophytes
9.	<i>Selliguea oxyloba</i> (Wall. exKunze) Fraser-Jenk.	Epiphytes; Lithophytes

Moisture requirement: Moist and shaded places are always preferable habitat of ferns and ferns allies majority of pteridophytes are grown in such condition some of the common ferns including: *Polystichum mehrae*; *Diplazium esculentum* etc.

Substratum preferences for terrestrial ferns

(i) Pteridophytes grow nutrients rich soil

Dark and dense forest areas, where there is relatively less light penetration and high water-holding capacity, are suitable for microbial growth. These microbes help decompose plant litter, which includes fallen leaves, branches, and other plant parts. The decomposition of this litter has a direct impact on soil characteristics and improves soil nutrient quality. In contrast, soils with low nutrient levels are commonly found along roadsides, on exposed walls, and in forests with fewer trees. Some species of pteridophytes that are flourished in nutrient rich soil are *Botrychium lanuginosum*, *Onychium Cryptogrammoides*, *Polypodiodes amoena*, *Polypodiodes lachnopus*, *Polystichum squarrosus*, and *Polystichum discretum* etc.

(ii) Pteridophytes grow nutrient deficit soil

Some species of pteridophytes that are also flourished in nutrient-deficient soil including: *Adiantum capillus-veneris*, *Arthromeris wallichiana*, *Aleuritopteris bicolor*, *Lepisorus nudus*, *Lepisorus mehrae*, *Microsorium membranaceum*, *Onychium cryptogrammoides*, *Pteris cretica*, *Pteris vittata*, *Polystichum squarrosus*, *Woodsia elongata* etc.

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Epiphytes: Epiphytic ferns are plants that grow on other plants. The host plants provide a suitable substratum for their growth and development. In the study area, some of the preferred host plants include *Quercus leucotrichophora*, *Quercus semecarpifolia*, *Lyonia ovalifolia*, *Rhododendron arboreum*, *Alnus nepalensis*, and *Aesculus indica*. Certain conifers, such as *Taxus baccata* and *Cedrus deodara*, also serve as suitable host plants for epiphytic ferns.

Distribution of ferns on host trees

The epiphytic ferns can be found to grow in both trees trunk, these ferns are also known as trunk epiphytic ferns, such as *Microsorium membranaceum*, *Loxogramma porcata*, *Oleandra wallichii* examples; *Drynaria mollis*, *Loxogramma porcata*, *Lepisorus nudus*, and *Selliguea oxyloba*. Another type of epiphytic fern found to grow in branches of host trees, are called branch epiphytes including *Vittaria himalayensis* etc. The third category consists of epiphytic ferns that reach the canopy including *Drynaria mollis*.

Lithophytes: Lithophytic ferns grow on hard surfaces such as stones, rocks and rocky substratum. Two groups of rocks are categorized on the basis of their surface properties: Dry and Barren Rocks and Damp and shaded rocks

(i) Dry and Barren Rocks: These rocks are totally barren with very modest soil. Rather, there are patches where humus accumulated, serving as a substrate for mosses and lithophytes ferns. The ferns and fern allies that grow on these exposed dry rocks might affect retaining walls.

The following ferns that grow on such rocks are *Adiantum spp.*, *Aleuritopteris spp.*, *Asplenium spp.*, etc.

(ii) Damp and shaded rocks: These rocks are found under dense forest lands where very low light can penetrate so always remains wet. These rocks are also found next to permanent hill streams and cascades. Sometimes, a small patches of mosses covers these rocks, while other times, they are barren.

The following ferns grow on such rocks: *Odontosoria spp.*, *Deparia spp.*, *Polystichum spp.*, *Microsorium spp.*, *Lepisorus spp.* etc.

Acknowledgement

The authors would like to express their sincere gratitude to Dr. Kamlesh Kumar Bhakuni, Assistant Professor, Department of Botany, L.S.M.P.G. College, Pithoragarh, Uttarakhand, for his expertise and valuable assistance in species identification. The authors also express their sincere gratitude to the local residents of the Hookra and Namik regions for their valuable support during field visits and data collection.

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