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Research Paper

A Survey of Pteridophytes from Hattian Jhelum valley Azad Kashmir Pakistan

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Abstract

Pteridophytes are central group of ecological succession in an ecosystem, which provide suitable microhabitat for their developments and sustainability. The ecological hypersensitivity of pteridophytes either due to microclimatic changes and anthropogenic pressure have made them excellent candidates for ecological indicator. The aim of present survey was to investigate the Pteridophytes in District, Jhelum Valley, Azad Jammu and Kashmir. The field surveys were conducted to study the ferns diversity and distribution in different ecological habitats type. A total of 63 taxa of Pteridophytes belonging to 31 genera and 16 families were collected from different localities of study area. The results showed that Pteridaceae and Thelypteridaceae were the leading families in terms of the number of genera (5 genera each), followed by Dryopteridaceae having 4 genera (13.33%) and 17 species (26.98%); Aspleniaceae, Cystopteridaceae and Dennstaedtiaceae with 2 genera (6.67%) each. The most frequently occurring genera observed including *Dryopteris, Adiantum*, *Asplenium*, *Cyrtomium*, *Cheilanthes*, *Polystichum*, *Polypodium*, *Pteris*, Pteridium, *Thelypteris*. The result of present study survey provides the first baseline data of pteridophytes in Jhelum valley, which support the key information of fern biodiversity in the study area.

Introduction

Pteridophytes (ferns) constitute the third major group of vascular plants, includes of 12838 ferns species belonging to19 orders and 58 families (Hasselar & Swale, 2001). Pteridophytes

grow in different habitats ranging from terrestrial to aquatic habitats, while a small number of species are also epiphytic. The moist and shady places support the rapid flourish and diverse distribution of ferns in various ecological zones of Pakistan (Saleem et al., 2000). Moist and humid conditions also favour the diversity of Pteridophytic flora in Azad Jammu and Kashmir, followed by Provinces of Punjab and Khyber Pakhtunkhawa (Gul et al., 2016). A total 133 species of ferns, belonging to 41 genera and 9 families were documented from mountainous regions and terrestrial habitats of West Pakistan and Kashmir (Stewart, 1972). A checklist was prepared including 130 species from District Mansehra grouped into 34 genera and 17 families by earlier researcher (Gul et al., 2016). Later on Gul et al. (2017) reported 202 Pteridophytes species of 62 genera and 19 families from Manshera, Pakistan, and Azad Kashmir.

In addition, 110 species collected from Azad Kashmir region. In Azad Jammu and Kashmir, ferns species also have key role in traditional basic health care system management by the local communities (Ahmed & Akhtar., 2016). Fraser-Jenkins and his colleagues (2018, 2020) recorded various types of ferns in far Western site of Himalayas and made a detailed list of these species in Pakistan. However, the exact geographical localities and distribution of these Pteridophytes were not exposed in their articles. Greater diversity in Azad Jammu and Kashmir has resulted due to variations in elevation, topography, habitat and climate amongst mountainous regions. Jhelum Valley is a District of state of Azad Jammu and Kashmir, Pakistan falls under Sino-Japanese Phytogeographical region of Pakistan.

Ferns are important tool to distinguish elevation gradient in mountainous region, their distribution greatly influenced by humidity, forest cover and anthropogenic pressure (Abotsi et al., 2020). Some previous studies established the major role of habitat constraints in shaping the geographical distribution and richness of extant of fern species (Gasper et al., 2015; Carvajal-Hernández, et al., 2017; Abosti et al., 2020; Susila et al., 2020; Zhang et al., 2020). Botanically, this region is one of the species diversity richest zones of the world (Ali & Qaiser, 1986). The investigated area of Dir Northern Pakistan has a diverse flora including19 Pteridophytes, 10 gymnosperms and 757 flowering plants species was reported by earlier researcher (Sirajuddin, 2007). Bryophytes and ferns are less explored in Azad Jammu and Kashmir as compared to higher vascular plants, so due to their ecological importance, they need to be explored for biodiversity data and conservation.

However, no study was reported relating to pteridophytes in Jhelum Valley. So, current study was designed for study survey from pteridophytes in Jhelum valley, Azad Jammu and Kashmir.

Materials and Methods

Study area

Jhelum Valley is situated between 73◦-75◦ longitude East and 33◦-36◦ North latitude. The geographical area of Jhelum Valley upto Indo-Pak border is about 17622 square kilometers. The average elevation is about 1830 m above sea level. On the north side of Kashmir, there are number of glacier resources which also contribute to Jhelum River. It covers all the divisions of Kashmir and is drained by important tributaries of river Jhelum (Akhter et al., 2017). It has rugged topography comprising mainly gullies and steep slopes where lime stones are mostly common. The climate is subtropical highland type with an average rainfall of 1300 mm. January is the coldest and June is the hottest month of the year. Generally, the summer season is much pleasant (Awan et al., 2020).

The Pteridophytic survey was conducted in selected areas of Jhelum Valley, district Azad Jammu and Kashmir During the survey, plant specimens of different was collected from various sites i.e Kachili, Kot Tarhala, Chakar,Cham, Lasdhar, Bani Hafiz, Batshiri, Nandi Ka Sar, Rawani, Domel, Sulmeya, Aenban and Saran. The field data was collected including different environmental variables (topographic and ecological information) from each site (Fig. 1). Topographic information included aspect, slope, elevation; latitude.

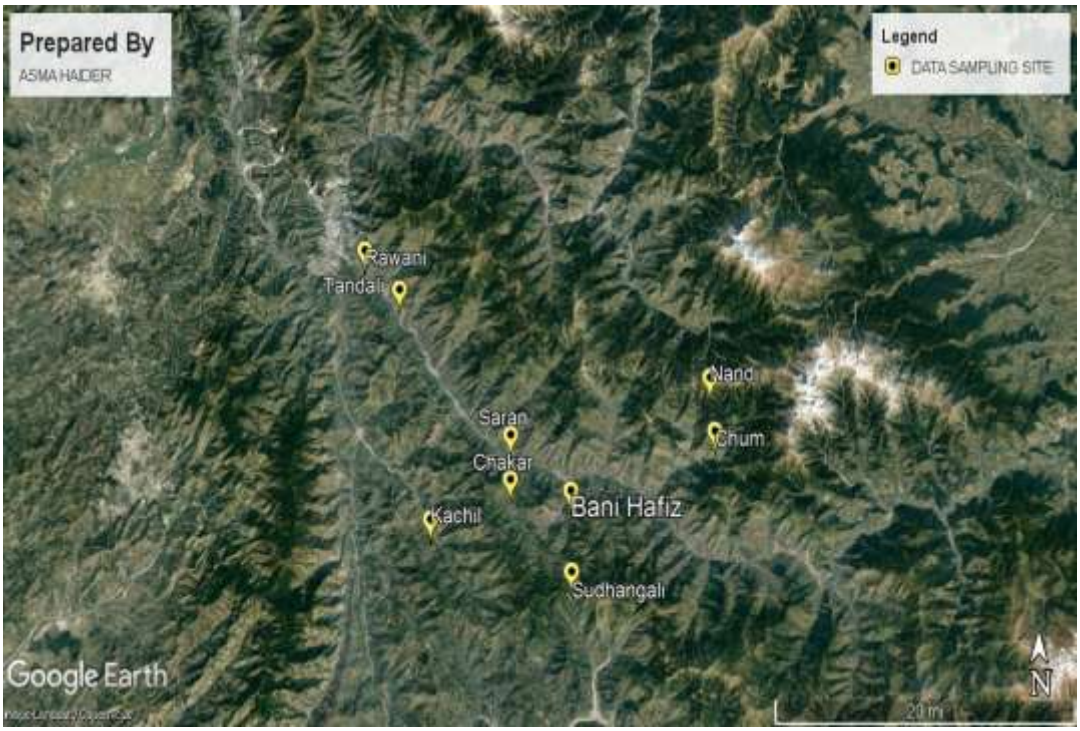

Fig 1. Map of study area of Hattian Jhelum valley.

Sampling methodology

During the field survey, ferns specimens were collected along altitudinal gradients from 810- 3420 m in various study sites. The specimens were collected in different habitats types including moist places, rocky crevices and in forest, grassland pastures and along the rivulets. As specimens collected, photographed, field number, aspect and altitude were noted in the notebook. The collected specimens were dried, pressed in the newspapers and finally dried specimens were mounted on Herbarium sheets. Mounted specimens were labeled along with species name, family, locality and altitude, type of habitat, date of collection, collection number and collector's name. The specimens were identified by available literature (Stewart, 1972), online flora of Pakistan (tropicos), flora of China, flora of North America and World Flora Online (Kindt et al., 2020). The preserved specimens were allotted voucher number and deposited in AKASH Herbarium Department of Botany, King Abdullah Campus, University of Azad Jammu and Kashmir (UAJK), Muzaffarabad-13100, Pakistan.

Results

The lush green valley of District Jhelum is presenting blue pines forests that provide shady habitats; ideal for ferns growth and development. The results revealed that a total of 63 fern species belonging 31 genera and 16 families were recorded in the present survey. Pteridaceae and Thelypteridaceae were leading families with 5 genera *Adiantum* (3spp.) *Pteris* (3spp.), *Pteridium* (3spp.), *Cheilanthes* (2spp.), O*nychium* (2spp.), *Thelypteris* (2spp.), *Cyclosoros* (1sp.), *Christella* (1sp.) *Glaphyropteridopsis* (1sp.), *Parathelypteris* (1sp). The family Dryopteridaceae has 4 genera *Dryopteris* (8spp.), *Polystichum (*6spp.),*Cyrtomium* (2spp) *Hypodematium* (1sp); Aspleniaceae with 2 genera *Asplenium* (6 spp.), *Ceterach* (1sp.); Cystopteridaceae with 2 genera *Cystopteris* (1sp.), *Gymnocarpium (*1sp.); Dennstaedtiaceae with 2 genera *Dennstaedtia (*1sp), *Pteridium* (1sp.); *Blechnaceae* with 1 genus *Woodwardia* (4spp.) were documented. However, Athyriaceae, Cibotiaceae, Equisetaceae, Marsileaceae and Woodsiaceae, Salviniaceae, Selaginellaceae and Onocleaceae sharing only 1 genus each (Table 1). A detailed result regarding families name, genus, scientific name, sites, altitude and specimen vouchers number were given in table 1.

Zone wise, the highest percentage was found in Upper temperate region with (63 taxa; 48%) followed by lower temperate having 41 species (31%). The Humid and Sub-tropics had less than 20 taxa (Fig 2). In terms of altitude, these taxa were abundantly distributed along altitudinal range 1300 m-2200 m, however, the species abundance were observed sharply

decreasing at above an elevation of 2600 m. Only few ferns were recorded at higher elevation namely *Parathelypteris glanduligera, Asplenium septentrionale* and *Adiantum formosum* at the site Nandi and Sudhangali. The ferns *Pteris vittata, Hypodematium crenatum, Polytichum luctuosum, Marsilea minuta,* and *Dryopteris intermedia* were found at lower elevation level in study site of Rwani, Tandali and Kahcilli.

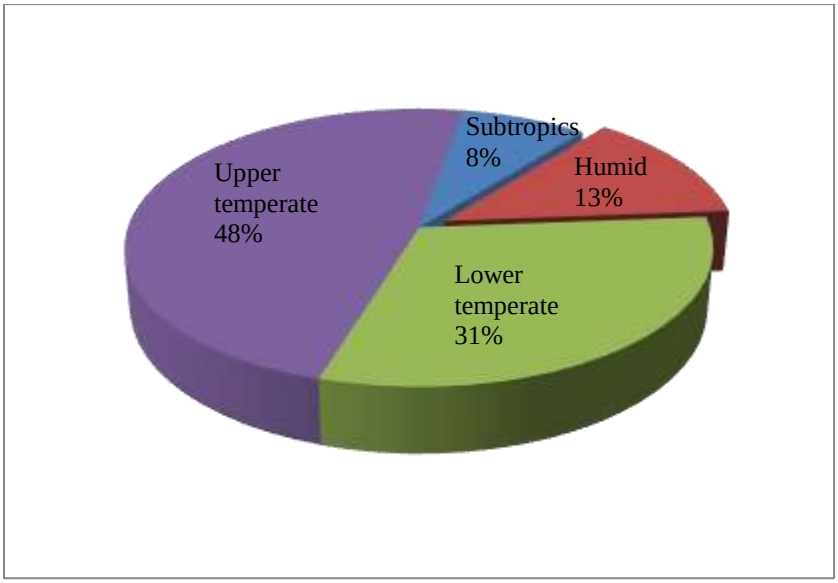

Fig 2. Ecological distribution of Pteridophytic taxa reported from study area.

Furthermore, the species *Asplenium septentrionale, Pteridium lineare, Pteridium revolutum* and *Woodwardia fimbriata* were found in association with *Selaginella chrysocaulos, Polypodium vulgare, Polystichum luctuosum* in different sites of the study area. It was observed that the maximum species of Pteridophytes were recorded in the North and South facing slope. It is suggested the slope, humidity and elevations have key role in distribution of ferns species at various elevation gradient. Locality wise, the maximum pteridophytic species were documented from site Nandi and Chakar followed by Kichili, Cham and Rawani. Figure 3 showing some pteridophytic genera from the different survey site.

Table 1. List of Pteridophytes collected from Jhelum Valley, Azad Jammu and Kashmir, Pakistan.

Family	Genus	Species	Locality	Altitude	Voucher no
Aspleniaceae	*Asplenium*	*Asplenium dalhousiae* Hook.	Kachili	1470 m	Haider51(AKASH)
		Asplenium septentrionale (L.)Hoffm.	Nandi	3020 m	Haider39(AKASH)
		Asplenium trichomanes L.	Nandi	2940 m	Haider45(AKASH)
	Ceterach	*Asplenium viride* Huds.	Chakar	1960 m	Haider9(AKASH)
		Asplenium adiantum-nigrum L.	Chakar	1920 m	Haider37(AKASH)
		Ceterach officinarum Willd.	Chakar	2090 m	Haider61(AKASH)
Athyriaceae	*Athyrium*	*Athyrium filix-femina* (L.) Roth	Sudhangali	3412 m	Haider33(AKASH)
Blechnaceae	*Woodwardia*	*Woodwardia fimbriata* Sm.	Cham	1920 m	Haider1(AKASH)
		Woodwardia areolata (L.) T. Moore	Nandi	1900 m	Haider32(AKASH)
		Woodwardia radicans (L.) Sm.	Kachili	1500 m	Haider47(AKASH)
		Woodwardia unigemmata (Makino)Nakai	Kachili	1530 m	Haider23(AKASH)
Cystopteridaceae	*Cystopteris*	*Cystopteris fragilis* (L.) Bernh.	Nandi	1940 m	Haider15(AKASH)
	Gymnocarpium	*Gymnocarpium dryopteris* (L.)Newman	Chakar	1900 m	Haider12(AKASH)
Dennstaedtiaceae	*Dennstaedtia*	*Dennstaedtia punctilobula* (Michx.)T. Moore	Nandi	1890 m	Haider13(AKASH)
	Pteridium	*Pteridium lineare* Ching ex S.H. Wu	Nandi	1890 m	Haider18(AKASH)

		Pteridium aquilinum (L.) Kuhn	Sudhangali	3400 m	Haider19(AKASH)
		Pteridium revolutum (Blume)Nakai.	Chakar	1900 m	Haider34(AKASH)
Dryopteridaceae	*Dryopteris*	*Dryopteris carthusiana* (Vill.) H.P.Fuchs	Nandi	1880 m	Haider8(AKASH)
		Dryopteris cristata (L.) A. Gray	Nandi	1880 m	Haider25(AKASH)
		Dryopteris erythrosora (D.C.Eaton) Kuntze	Nandi	1790 m	Haider6(AKASH)
		Dryopteris expansa (C. Presl) Fraser-Jenk. & Jermy	Chakar	1910 m	Haider28(AKASH)
		Dryopteris filix-mas (L.) Schott	Chakar	1900 m	Haider50(AKASH)
		Dryopteris fragrans (L.) Schott	Nandi	1880 m	Haider44(AKASH)
		Dryopteris intermedia (Muhl.ex Willd.)A.Gray	Tandali	812 m	Haider58(AKASH)
		Dryopteris nigropaleacea (Fraser-Jenk.) Fraser-Jenk.	Nandi	1870 m	Haider54(AKASH)
	Hypodematium	*Hypodematium crenatum* (Forssk.) Kuhn,v. Deck.	Tandali	810 m	Haider40(AKASH)
	Polystichum	*Polystichum aculeatum* (L.) Roth ex Mert.	Chakar	1900 m	Haider11(AKASH)
		Polystichum braunii (Spenn.) Fée	Nandi	1880 m	Haider27(AKASH)

		Polystichum lonchitis (L.) Roth	Nandi	1880 m	Haider38(AKASH)
		Polytichum luctuosum (Kunze) T.Moore	Kachili	1520 m	Haider3(AKASH)
		Polystichum setiferum (Forssk.) Moore ex Woyn.	Nandi	1880 m	Haider30(AKASH)
		Polystichum yunnanense Christ.	Nandi	1870 m	Haider16(AKASH)
	Cyrtomium	*Cyrtomium caryotideum var. micropterum* (Kunze) C. Chr.	Chakar	1920 m	Haider42(AKASH)
		Cyrtomium falcatum (L. f.) C. Presl	Chakar	1900 m	Haider7(AKASH)
Equisetaceae		*Equisetum arvense* L.	Nandi	1880 m	Haider36(AKASH)
	Equisetum	*Equisetum ramoissimum subsp.debile* (Roxb.ex.Voucher).	Cham	1920 m	Haider56(AKASH)
Lygodiaceae	*Lygodium*	*Lygodium japonicum* (Thunb.) Sw.	Banihafiz	1490 m	Haider41(AKASH)
		Lygodium microphyllum (Cav.) R.Br.	Banihafiz	1490 m	Haider21(AKASH)
Marsileaceae	*Marsilea*	*Marsilea minuta* L.	Rawani	820 m	Haider49(AKASH)
Onocleaceae	*Matteuccia*	*Matteuccia struthiopteris* (L.) Tod.	Sudhangali	34 20 m	Haider57(AKASH)
Polypodiaceae	*Polypodium*	*Polypodium appalachianum* Haufler & Windham	Cham	1920 m	Haider60(AKASH)
		Polypodium vulgare L.	Chakar	1910 m	Haider17(AKASH)
Pteridaceae	*Pteris*	*Pteris cretica* L.	Chakar	1910 m	Haider10(AKASH)
		Pteris multifida Poir.	Nandi	1900 m	Haider48(AKASH)
	Adiantum	*Pteris vittata* L.	Rawani	820 m	Haider20(AKASH)
		Adiantum capillus-veneris L.	Chakar	1900 m	Haider2(AKASH)

	Cheilanthes	*Adiantum formosum* R.Br.	Sudhangali	3420 m	Haider5(AKASH)
		Adiantum venustum D. Don	Chakar	1900 m	Haider31(AKASH)
			Tandali	820 m	Haider46(AKASH)
		Adiantum caudatum G. Forst.			
		Cheilanthes argentea (S.G. Gmel.) Kunze	Nandi	1880 m	Haider35(AKASH)
		Cheilanthes farinosa (Forssk.) Kaulf.	Rawani	810 m	Haider62(AKASH)
	Doryopteris	*Doryopteris concolor* (Langsd. & Fisch.) Kuhn	Nandi	1900 m	Haider14(AKASH)
	Onychium	*Onychium contegium* Wall. ex Hope	Chakar	1910 m	Haider26(AKASH)
		Onychium japonicum (Thunb.) Kunze	Chakar	1920 m	Haider22(AKASH)
Salviniaceae	*Salvinia*	*Salvinia natans* (L.) All.	Rawani	810m	Haider63(AKASH)
Selaginellaceae	*Selaginella*	*Selaginella chrysocaulos* (Hook. & Grev.) Spring	Cham	1890 m	Haider59(AKASH)
Thelypteridaceae	*Thelypteris*	*Thelypteris xylodes* (Kunze) Ching	Chakar	1900 m	Haider24(AKASH)
		Christella dentata (Forssk.) Brownsey & Jermy	Chakar	1900 m	Haider4(AKASH)
		Cyclosorus interruptus (Willd.) H. Itô	Chakar	1900 m	Haider52(AKASH)
		Glaphyropteridopsis rufostraminea (Christ) Ching	Chakar	1910 m	Haider29(AKASH)
		Parathelypteris glanduligera (Kunze) Ching	Sudhangali	3420 m	Haider55(AKASH)
Woodsiaceae	*Diplazium*	*Diplazium esculentum* (Retz.) Sw.	Nandi	1890 m	Haider43(AKASH)

Figure 3. Photographs of eight Pteridophytes species from different sites in the study area.

Discussion

Pteridophytic flora remains an important part on earth since prehistoric era (Pryer et al., 2001). Investigation of fern flora gained less importance as compared to flowering plants (Dar et al., 2002). An attracting feature of Azad Jammu and Kashmir is varying in altitudinal range and topography by showing diverse habitat for Pteridophytes biodiversity. The results showed that leading families such as Dryopteridaceae, Pteridaceae and Aspleniaceae were recorded with almost more than 61% to regional flora, whereas remaining 14 families contributed about 39% in the local flora. Similar results reported in a previous study that the distributions of ferns among the families were unequal, with four families constituting more than half of the total species (Dryopteridaceae 26%, Woodsiaceae 17%, Aspleniaceae 14%, and Pteridaceae (14%). The highest numbers of species (45%) were found growing on the forest floor, followed by those growing in rock crevices (26%) (Khoja et al., 2022).

The total number of fern species recorded from present survey was quit low as compared to few other studies from neighboring areas in Western Himalayas (Gul et al., 2016; 2017), which might be due to total surveyed study areas. Iltaf et al. (2012) were recorded diverse

pteridophytic (36sp) distributed in 13 families from Punjab with dominant families were found to be Dryopteridaceae and Aspleniaceae. Another study reported eleven species of ferns represented by 7 families from Western Himalayas (Gautam et al., 2016). On the other hand, the total number of species documented from District Mansehra is quite high that cover an area of 4,579 sq. km. In present study, the survey was limited to the District Jhelum Valley which encompasses about 500 sq. km^{-1} only which was quite low as compared to other studies (Gul et al., 2016; 2017; Saleem et al., 2000). However, the diversity of ferns in present survey was recorded higher in terms of the proportionate to the number of species previously reported in different area.

The study reveals that the species growing in shaded hilly areas included, *Adiantum* capillus-veneris, *Asplenium trichomanes, Asplenium adiantum -nigrum, Polypodium vulgare, Pteridium lineare, Pteridium lonchitis, Dryopteris intermedia, D.cristata, Polystichum braunii. Marsilea minuta* and *Salvinia natans* were only two species growing in aquatic habitat. Forests habit type included trees *Cedrus deodara, Pinus roxburgi, Pinus wallichiana, Aesculus indica ,Juglans regia* and *Quercus quardifolia*.

The results revealed that genus *Dryopteris* shared 13% to fern flora in terms of number of species. The remaining 3 genera contributed more than 50% species. Similarly findings was recorded in a previous study that *Dryopteris* is a diverse genus that shared 15% species from district Tor Ghar (Bibi et al., 2021). In present study, species of dominating genera were made newly reported from the area of Nandi, Chakar bandi, Cham, Kachili and Tandali to Pakistan. Maximum species of pteridophytes were collected from Nandi and Chakar during field survey. Tandali and Rawani shared minimum ferns species. It is suggested that the minimum rainfall, least moist shady places in these area is the cause of least pteridophytic diversity. However, Gul et al. (2017) assumed that the Pakistan and Kashmir region have 70% ferns diversity owing to rainfall, shady slope and moist areas. It was observed that, the majority of Pteridophytic taxa was distributed between ranges of 1300-2700 m. Minimum species of ferns were recorded at elevation of 3000-3420 m. it is suggested that the Pteridophytic abundance might be moist and shady slope habitat. These regions vary from climatic conditions; sloppy mountains and heavy precipitation create suitable habitats for Pteridophytic growth (Gul et al., 2017). Another reason for rich diversity for fern taxa exists due to topographic features. It is reported in previous study from India, that an altitudinal range of 1701-2000 m was found most favorable zone for growth of Pteridophytic species (Chandra, 2000). However, in the present survey, the species diversity at above 2000 might be slope effect and dense forest that retained moisture in these areas.

In addition, the fern were mostly distributed along elevation gradient restrained to their habitat by specific climatic factors (Abotsi et al., 2020., Acebey et al., 2017). Previously reported studies confirmed that the ferns species are usually constrained in their distribution by the collective effect of humidity, elevation, insolation, and human activities (Gasper et al., 2015; Gul et al., 2017; Abosti et al., 2020; Susila et al., 2020). In Pakistan, group of Pteridophytes have not been much focused, as few researchers worked to investigate this plant clade (Nakaike and Malik; 1992, 1993). It is worth noting that workers concentrated on fern flora of Kashmir, but majority areas are still unexplored in Azad Jammu and Kashmir, Pakistan. The Himalayan region of Pakistan and Kashmir boasts the maximum diversity of Pteridophytes. Highest concentration is likely caused by frequent rains and presence of forest type habitat. Minimum species were documented from Hindu-kush and Karakoram range. However, the lower rainfall from Eastern to Western Himalayan highlands is reason of low fern diversity. Since humidity, shade, forest cover and altitudinal range enhance diversity and growth of Pteridophytes (Gul et al., 2017).

Conclusion

The current survey revealed 63 ferns belonging to 16 families distributed among 31 genera. Dryopteridaceae was the largest family with 17 species followed by Pteridaceae with11 species. The Genus *Dryopteris* was recorded as dominant followed by *Asplenium* and *Polystichum.* The study revealed that the fern species generally constrained in their distribution by the combined effect of humidity, elevation gradients and slope aspect. It is suggested that further study should be conducted on fern species diversity and distribution in relation with forest disturbance and consumed by human. Furthermore, it is essential to promote ethno-ecological aspects of fern species for sustainable forest development and conservation.

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