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Diversity, Ecological and Traditional Knowledge of Pteridophytes in the Western Himalayas

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Abstract: Pteridophytes have been used by humans for millennia, but in comparison to flowering plants, the documentation of their traditional uses is still neglected; as a result, they must be highlighted and popularized. The present study was carried out from January 2019 to November 2021 to gather ecological and traditional use information on pteridophytes from local inhabitants of the Kashmir valley via semi-structured personal interviews and group discussions. We recorded 58 pteridophyte species belonging to 13 families. The distributions of the species 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%). This was supported further by a cluster analysis, which identified two primary clusters based on the species presence in different habitats. Half of the species (56%) were reported from altitudes below 2000m, followed by 19% from 2001–2500m, and 8% (e.g., *Deparia allantodioides, Dryopteris xanthomelas, Asplenium viride*) from 3001–3500m. Among the documented species (N = 58), only 28 species had a traditional usage (as medicine, vegetables, for oral hygiene, and for veterinary use). The aerial parts were most commonly used (64%) followed by the rachis (18%). The highest use value was observed for *Diplazium maximum* and the lowest for *Asplenium fontanum*. The findings of our study contribute baseline data to fill the existing knowledge gaps on ecological and traditional knowledge of pteridophytes in the Himalayas.

Keywords: altitude; composition; habitat; distribution; Kashmir Himalayas

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1. Introduction

Pteridophytes are a plant group that falls between non-tracheophytes and spermatophytes and account for over 48 families, 587 genera, and 12000 species worldwide [1–3]. The richness of the species is affected by the rainfall, moisture, and habitat availability [4]. Most species are found in tropical and moist temperate regions followed by subtropical regions [5]. They are widely utilized as vegetables, traditional remedies, and for land scaping and gardening [6]. Proteins, vitamins, crude fiber, and minerals are all found in edible pteridophytes, and steroids, terpenoids, phenolic acids, and flavonoids are only a few of the compounds found in them [7].

Pteridophytes were considered a source of medicines in ancient times but remain relatively under explored. However, fern ethnobotany is not new [8], and there is a wealth of information regarding ferns and local cultures in the literature. On a global scale, [8] offered the most thorough analysis of the usage of lycophytes and ferns, but they have also been studied ethnobotanically in South America [9]. Asia has a great diversity of pteridophytes, but their uses have not been well recorded except for a few studies in China and India [10,11].

The Kashmir valley is an integral but geologically younger part of the Himalayan range [12]. Due to topographical, altitudinal, and geographical variation, the valley represents a vast habitat diversity and floristic richness, which is of immense scientific interest and economic potential [13]. The available scientific literature on the flora of the valley indicates that while phanerogams are well documented, little attention has been paid to pteridophytes [12]. Nevertheless, the earliest reported study of the pterido-flora of Kashmir dates back to 1880 [14], and other studies include those found in [15–28]. The valley is inhabited by diverse ethnic people with unique living patterns, and most people reside in rural areas and possess a strong relationship with the natural resources. This relationship with nature has been documented [29–32].

However, the research on pteridophytes still focuses on taxonomy [12,25–28] and there are no available studies on traditional use. A few scattered reports are available for ferns and fern-allies from other regions [26–29]. The present study was designed not only to assess the medicinal importance of pteridophytes but also other uses by the indigenous people, highlighting their economic potential for the area under study. In this regard, the present study aimed:

To document the pteridophyte species with ethno-usage;

To evaluate the ecological knowledge of the local inhabitants of the Kashmir valley regarding the pteridophytes;

To analyze the further distribution of species at different altitudes.

2. Materials and Methods

2.1. Study Area

Kupwara (Figure 1) is a frontier area in the Union territory of Kashmir, which is mainly mountainous with rich flora. The region covers an area of 2379 km^2 and this area is mostly rural, including 368 villages with a population of 870,354 persons and a population density of 366 persons/km^2 [33].The area is very biodiverse, with dense forests (Himalayan dry-temperate to subalpine forest types) [34]. The climate is of the dfb type, with temperatures falling below −4 °C in winters and reaching 32 °C maximum in summer [35].

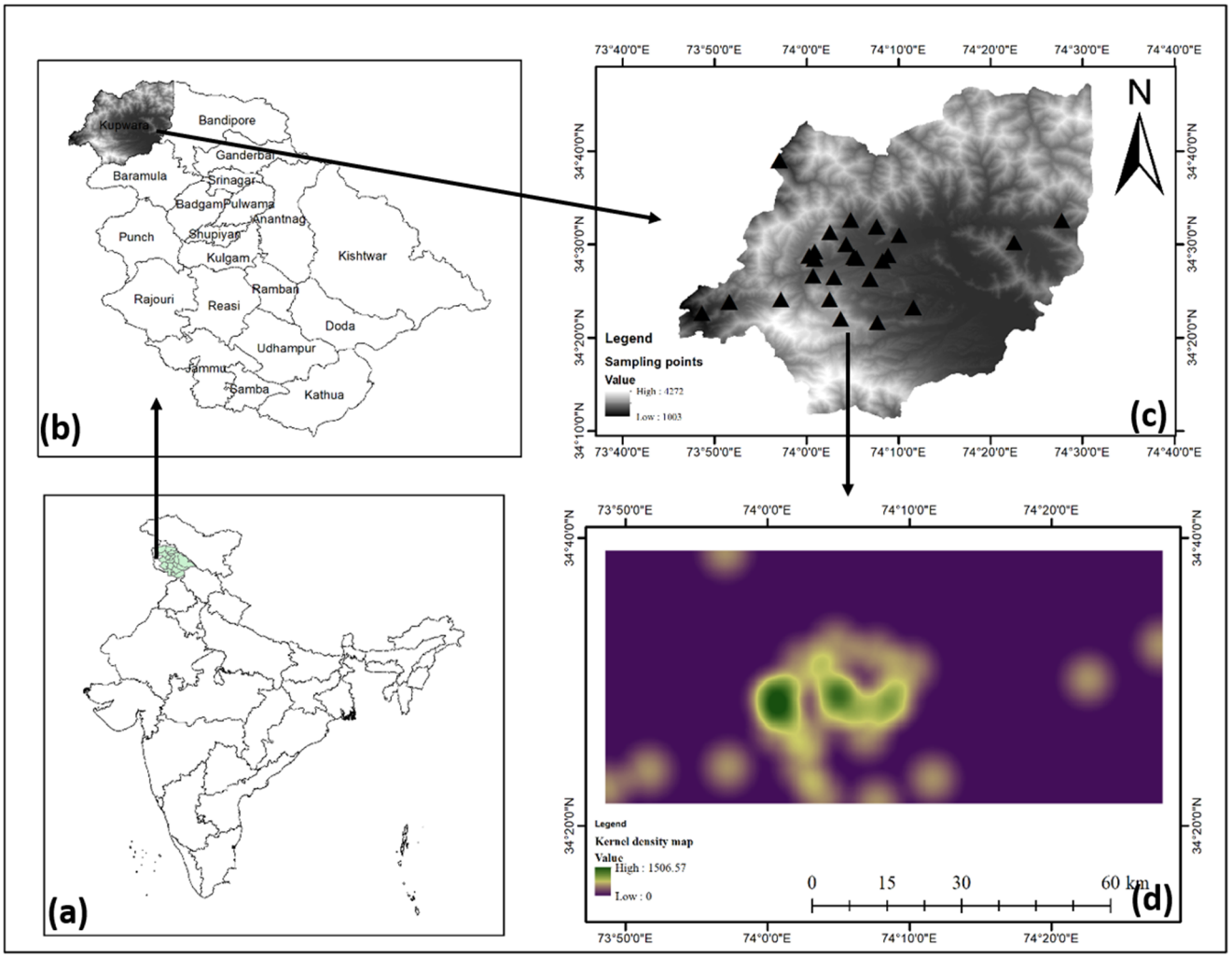

Figure 1. (**a**) Map of India, (**b**) map of Jammu and Kashmir, (**c**) map showing surveyed villages in the District of Kupwara, and (**d**) Kernel density map of the sampled villages.

2.2. Survey Methodology

The present study was carried out from January 2019 to November 2021 to gather traditional use reports and ecological information of pteridophytes from the local inhabitants. Ecological data were collected along the altitudinal gradient from 1500–3450 m. During the surveys, data pertaining to the field-based ecological knowledge—such as habitat types of each of the documented species—was collected [36]. The different habitat types included forest floor, rock crevices, grassland pastures, moist paces, and riparian [37]. The ethnobiological information was gathered through semi-structured interviews and group discussions [38,39]. Before interviews, verbal prior informed consent was obtained, and the code of ethics was followed in all aspects of the study (International Society of Ethnobiology. Code of Ethics. 2006) (https://www.ethnobiology.net) (accessed on 28 August 2020). All information was obtained in local language by hiring a translator and local field guide.

2.3. Preservation and Identification of Collected Plants:

The specimens collected from the field were shade-dried and processed into herbarium specimens following standard techniques [40]. The identification was performed with the assistance of Prof. S.P. Kullar (Chandigarh) and Mr. C.R. Fraser-Jenkins (Portugal). Herbarium specimens were deposited in the Department of Taxonomy, University of Kashmir, for future references. The botanical names of the plant species were verified using

the Plant List (www.theplantlist.org) (accessed on 28 August 2020. A comparative literature review was conducted to evaluate the possible novelty of the findings.

2.4. Demography of Informants

A total of 58 local individuals, comprising 39 (67.24%) men and 19 (32.75%) women, were selected for the interviews. Due to cultural limitations, the number of male respondents was higher [41–43]. Most of the respondents were illiterate (65.51%). Older people (55.17%) had greater traditional knowledge compared to the young (10.34%). The respondents belonged to a variety of professions among which shepherds were the most common (36.20%), followed by skilled laborers (24.13%), farmers (22.41%), and housewives (17.24%) (Table 1).

Table 1. Demography of informants from the study area.

Informants	Number	Percentage
Total	58	100
Men	39	67.24
Women	19	32.75
Age groups		
Young 25–40 years	6	10.34
Middle aged 41–55 years	20	34.48
Old aged 56–75 years	32	55.17
Occupation		
Shepherds	21	36.20
Farmers	13	22.41
Skilled laborers	14	24.13
Housewives	10	17.24
Education		
Illiterate	38	65.51
Primary	13	22.41
Secondary	7	12.06

2.5. Data Analysis

For the dendrogram, presence/absence of data was used to elucidate species distribution in particular clusters based on the same habitat type [44]. The Sorensen's (Bray–Curtis) distance was used to identify significant differences among diverse habitat types and plant resemblances using Past software ver. 3.14 [45]. A Kernel density map was prepared using ARCGISver.10.5. This depicts hotspots in the landscape, with the darker red color indicating greater species number. We used absence/presence data to depict the distribution of the species on the heat map, and the subsequent cluster analysis will combine species with comparable altitudinal ranges. The program "circlize package" [46] was used to construct chord diagrams in R software 4.0.0. [47]. This graph allows us to see which species in each group and which altitude group has the greatest number of species based on the thickness of each bar [39].

3. Results and Discussions

3.1. Taxonomic Composition

During the present study, we recorded 58 pteridophyte species belonging to 13 families (Figure 2a). The current documentation is the first of its kind from the valley, as no such study related to pteridophytes has been carried out in the region as per our knowledge. Irfan et al [48], who reported 168 taxa belonging to 45 genera and 19 families from Pakistan, Rajput et al. [49] reported 23 species from Gujrat India, Uday et al. [50] reported 77 species

belonging to 15 families from Jhargram district of southwest Bengal, and Bibi et al. [51] reported 45 species belonging to 10 families from Ghar KP, Pakistan.

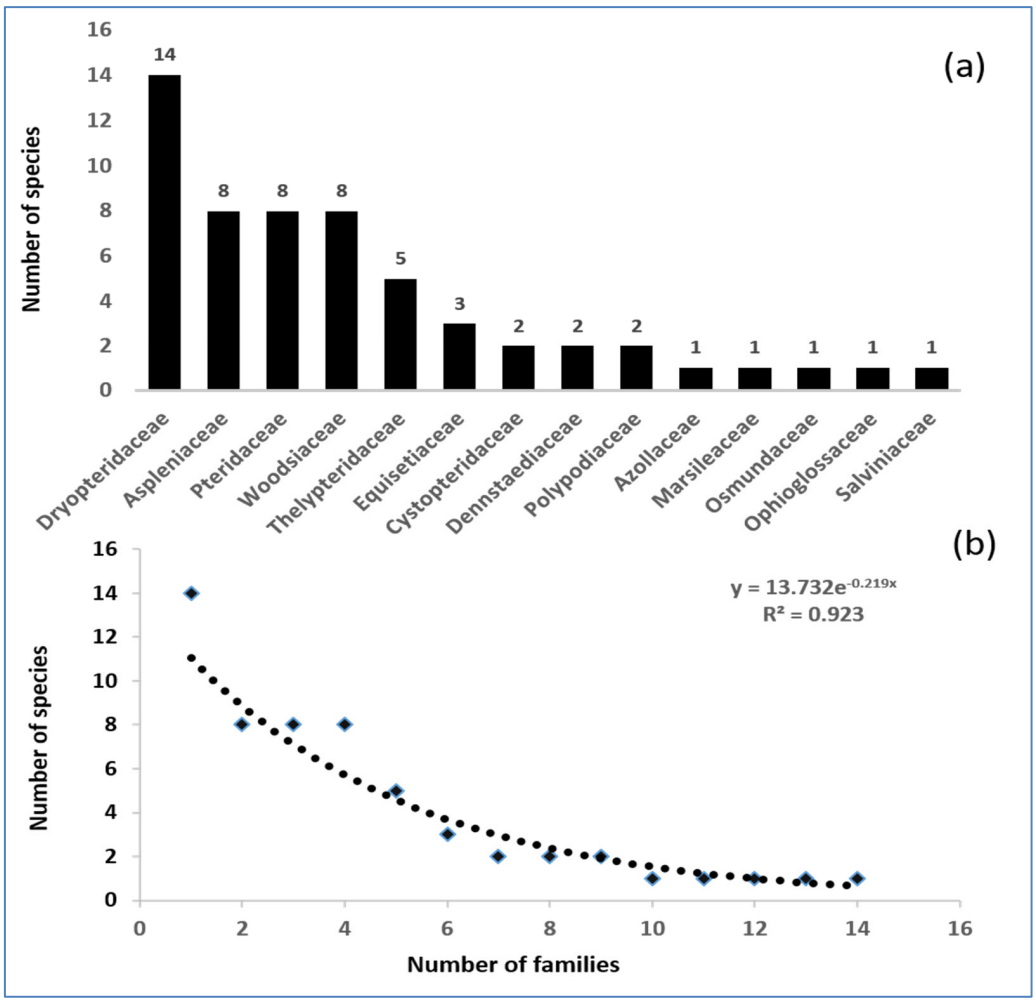

Figure 2. (**a**) Percentage of families; (**b**) species–family relationship of the documented species in the study area.

The distribution of species (Figure 3) in the families was unequal, with four families constituting more than half of the total species (Dryopteridaceae (N = 14), Woodsiaceae, Aspleniaceae, and Pteridaceae (N = 8 each). The family species relationship ($y = 13.732e^{-0.219x} R^2 = 0.923$) can be observed (Figure 2b). Our results are similar to Bibi et al. [51], who also reported Dryopteridaceae as the dominant family while evaluating the diversity from Ghar, KP, Pakistan; likewise, Irfan et al. [52] reported Dryopteridaceae as the dominant family from Battargam, KP, Pakistan. Gul et al. [53] also reported Dryopteridaceae as the leading family from Pakistan. Our inventory of the documented flora including the scientific name, local name, family, attitude, habitat, and the 11 villages is presented in Table 2. Among all the study sites, most of the species were reported from Thandipora (31%), followed by Rashanpora-Dutt (14%) and Budnamal (10%) (Table 2).

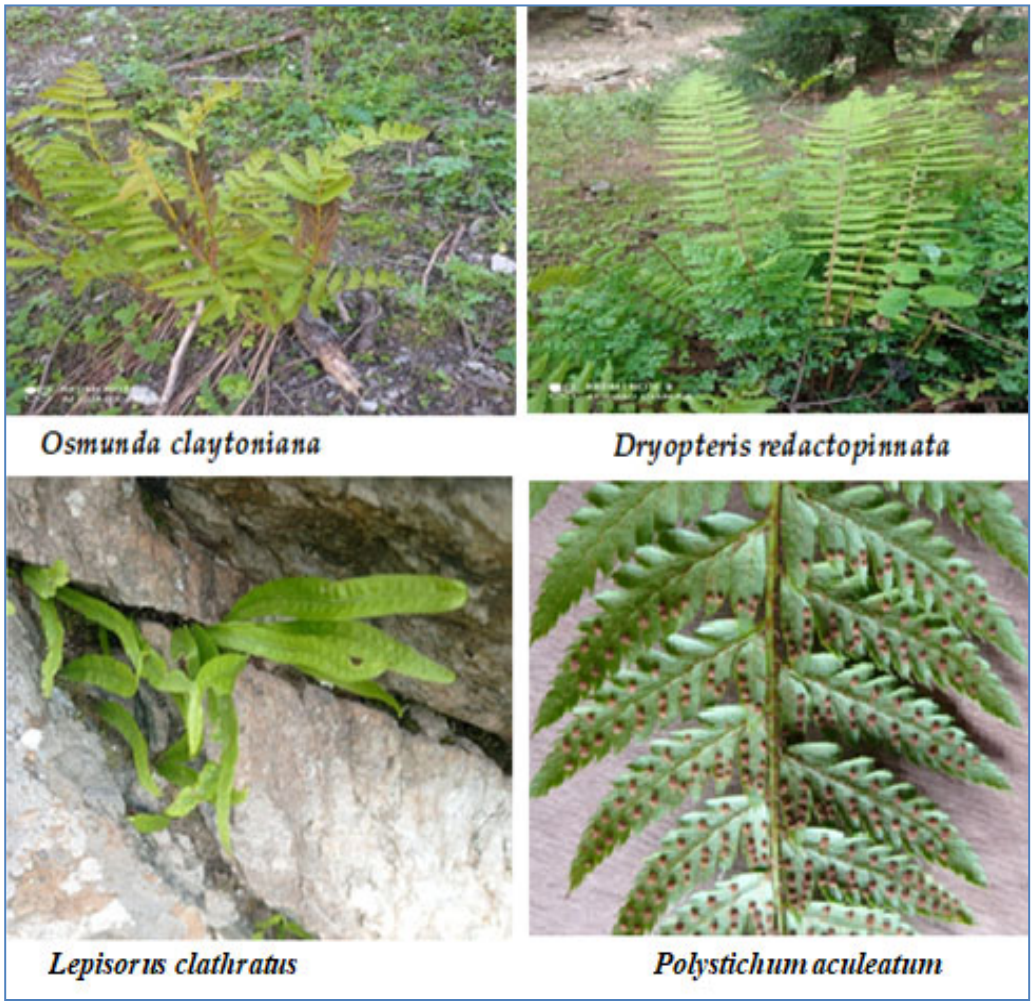

Figure 3. Representation of the species collected during the field study. (P.C. *Aadil Abdullah Khoja*).

Table 2. Inventory of the documented species from the administrative Kupwara district of Jammu and Kashmir.

Family	Botanical Name/Voucher No.	Local Name	Village	Altitude	Habitat	Toxicity	Part Used	Ethno-Use	Use Value
Aspleniaceae	*Asplenium adiantum-nigrum* L. Asp adi KUP-001	Guewtheer	Thandipora	1900	Forest floor	×	Areal part	Used to treat jaundice	0.63
	Asplenium ceterach L. KUP-002 Asp cet	Reach	Thandipora	1900	Rock crevice	×	Areal part	Used to treat kidney stones	0.33
	Asplenium fontanum (L.) Bernh. subsp. *pseudofontanum* KUP-003 Asp fon	Sheen-ghass	Budnamal	2500	Rock crevice	×	Areal part	Used to treat respiratory diseases	0.29
	Asplenium dalhousiae Hook. KUP-007 Asp dal		Thandipora	1900	Moist places	√			
	Asplenium laciniatum D. Donsubsp. *laciniatum* KUP-008 Asp lac		Keran	2500	Rock crevice	√			
	Asplenium septentrionale (L.) Hoffm. KUP-004 Asp sep		Rashanpora Dutt	3100	Rock crevice	×			
	Asplenium trichomanes L. KUP-005 Asp tri	Guewtheer	Thandipora	1950	Rock crevice	×	Areal part	Used to treat Jaundice	0.34
							Rachis	Used as toothpick. Employed after ear piercing for a week before use of earrings.	0.50
	Asplenium viride Huds. KUP-006 Asp vir	Lakitguewtheer	Chowkibal	2200	Rock crevice	×	Frond	Used to treat sun burns	0.36

Table 2. *Cont.*

Family	Botanical Name/Voucher No.	Local Name	Village	Altitude	Habitat	Toxicity	Part Used	Ethno-Use	Use Value
Azollaceae	*Azolla filiculoides* Lam. subsp. *cristata* KUP-009 Azo fil		Lolab	1600	Riparian zone	×			
Cystopteri- daceae	*Cystopteris fragilis* L. KUP-047 Cysfra		Thandipora	1950	Rock crevice	×			
	Cystopteris fragilis nonthosubsp. x *montserratti* Prado and Salvo KUP-048 Cysfra		Marsari	1900	Rock crevice	×			
Dennstae- diaceae	*Pteridium brownseyi* Fraser-Jenk. KUP-010 Pte bro	Longud	Satboin	2500	Forest floor	×	Young frond	Used as vegetable	0.53
	Pteridium revolutum Blume KUP-011 Pte rev	Longud	Sadnatop	2800	Grassland pastures	√	Young frond	Used as vegetable and for Asthma	0.60
Dryopterid- aceae	*Dryopteris barbigera* T. Moore ex Hook. KUP-012 Dry bar	Kaw-dead	Rashanpora Dutt	3000	Grassland pastures	√	Areal part	Used as bedding for livestock during winters	0.41
	Dryopteris blanfordii C. Hope KUP-013 Dry bla	Hapat-daed	Rashanpora Dutt	3000	Grassland pastures	√	Areal part	Used as bedding for livestock during winters	0.38
	Dryopteris juxtaposita Christ. KUP-014 Dry jux	Hapat-daed	Farkan	1900	Forest floor	√	Areal part	Used as bedding for livestock during winters	0.40
	Dryopteris nigropaleacea (Fraser-Jenk.) Fraser-Jenk. KUP-015 Dry nig		Farkan	2000	Forest floor	√			
	Dryopteris ramosa (C.Hope) C. Chr. KUP-016 Dry ram	Dead	Farkan	1900	Forest floor	√	Areal part	Used as vegetable	0.48
	Dryopteris redactopinnata S.K. Basuand Panigrahi KUP-017 Dry red	Kaw-daed	Budnamal	2500	Forest floor	×	Areal part	Used as bedding for livestock during winters	0.36
	Dryopteris stewartii Fraser-Jenk. KUP-018 Dry ste	Kaw-daed	Farkan	1900	Forest floor	√	Areal part	Used as vegetable	0.43
	Dryopteris xanthomelas (Christ) C. Chr. KUP-019 Dry xan		Sadnatop	2400	Forest floor	×			
	Polystichum aculeatum L. 4246-KASH Pol acu	Kaw-daed	Farkan	1950	Forest floor	√	Areal part	Used as bedding for livestock during winters	0.45
	Polystichum discretum (D. Don) J. Smith KUP-020 Pol dis	Kaw-daed	Farkan	1950	Forest floor	√	Areal part	Used as bedding for livestock during winters	0.39
	Polystichum lonchitis (L.) Roth *KU-023* *Pol lon*		Bungus valley	3100	Forest floor	√			
	Polystichum piceopaleaceum Tagawa KUP-024 Pol pic	Hapat-daed	Thandipora	1950	Forest floor	√	Areal part	Used as bedding for livestock during winters	0.46
	Polystichum squarrosum D. Don. KUP-022 Pol squ	Jungle-daed	Thandipora	1950	Forest floor	√	Areal part	Vegetable	
	Polystichum yunnanense Christ. KUP-026 Pol yun		Thandipora	1950	Forest floor	√			
Equisetiaceae	*Equisetum arvense* L. 4232-KASH Equarv	Gandamgud	Thandipora	1900	Moist areas	×	Rachis	Used for cleaning teeth	0.65
	Equisetum diffusum D. Don 4233-KASH Equdif	Gandamgud	Thandipora	1900	Moist areas	×	Rachis	Used for cleaning teeth	0.60
	Equisetum ramosissimum Desf. KUP-027 Equ ram		Thandipora	1900	Rock crevice	×			
Marsileaceae	*Marsilea minuta* L. KUP-028 Mar min	Paflu	Sat-boin	1600	Riparian zone	×	Rhizome	Diuretic	0.43
Osmundaceae	*Osmunda claytoniana* L. KUP-029 Osmcla	Mubrakhgul	Rashanpora Dutt	3000	Grassland pastures	×	Areal part	Used as bedding for livestock during winters	0.33
Ophioglossaceae	*Ophioglossum reticulatum* L. KUP-030 Oph ret	Chan-choor	Thandipora	1950	Grassland pastures	×	Roots	Used as wound-healing agent	0.45
Polypodiaceae	*Lepisorus clathratus* (C.B. Clarke) Ching KUP-031 Lepcla		Rashanpora Dutt	3100	Rock crevice	×			
	Lepisorus nudus (Hook.) Ching, KUP-032 Lepnud		Rashanpora Dutt	3100	Rock crevice	×			

Table 2. *Cont.*

Family	Botanical Name/Voucher No.	Local Name	Village	Altitude	Habitat	Toxicity	Part Used	Ethno-Use	Use Value
Pteridaceae	*Adiantum capillus-veneris* L. 4115-KASH Adi cap	Guewtheer	Thandipora	1900	Forest floor	×	Rachis	Used as toothpick. Employed after ear piercing for a week before use of earrings.	0.55
	Adiantum venustum D. Don. 4104-KASH Adiven	Guewtheer	Marsari	1900	Forest floor	×	Rachis	Used as toothpick. Employed after ear piercing for a week before use of earrings.	0.57
	Adiantum tibeticum Chingand Y.X. Lin. KUP-033 Adi tib	Guewtheer	Thandipora	1900	Forest floor	×	Rachis	Used as toothpick. Employed after ear piercing for a week before use of earrings.	0.53
	Cryptogramma brunoniana Wall. ex Hook. KUP-034 Cry bru		Chowkibal	2000	Rock crevice	×			
	Cryptogramma stelleri (S.G. Gmel.) Prantl KUP-035 Cry ste		Budnamal	2500	Rock crevice	×			
	Onychium cryptogrammoides Christ KUP-036 Ony cry		Thandipora	2000	Grassland pastures	×			
	Pteris cretica L. KUP-037 Pte cre	Jungle-daed	Thandipora	1900	Forest floor	×	Areal part	Used as wound-healing agent	0.45
	Pteris vittata L. KUP-038 Pte vit		Satboin	1600	Forest floor	×			
Salviniaceae	*Salvinia natans* L. KUP-039 Sal nat		Satboin	1600	Riparian zone	×			
Thelypterid- aceae	*Thelypteris levingei* Clarke Ching KUP-040 The lev		Marsari	1900	Forest floor	×			
	Thelypteris microstegia subsp. *microstegia* E.W. Trotter and Hope KUP-041 The mic		Budnamal	2500	Forest floor	×			
	Thelypteris microstegia subsp. *laterepens* (E.W. Trotter) Fraser-Jenk. KUP-042 The mic		Budnamal	2500	Forest floor	×			
	Thelypteris palustris Schott KUP-043 The pal		Thandipora	1950	Rock crevice	×			
	Phegopteris connectilis (Michx.) Watt KUP-044 Phe con		Bungus valley	2550	Moist areas	×			
Woodsiaceae	*Athyrium attenuatum* (C.B. Clarke) KUP-062 Ath att		Bungus valley	2550	Grassland pastures	×			
	Athyrium dubium Ching KUP-046 Ath dub		Rashanpora Dutt	3000	Grassland pastures	×			
	Athyrium mackinnoniorum (C. Hope) C. Chr. KUP-045 Ath mac	Daed	Thandipora	1950	Forest floor	√	Areal part	Used as Vegetable	0.36
	Deparia allantodioides (Bedd.) M. Kato KUP-049 Dep all		Budnamal	2400	Forest floor	×			
	Deparia japonica Thunb. KUP-050 Dep jap		Sadnatop	2800	Forest floor	×			
	Deparia petersenii Kunze KUP-051 Dep pet		Sadnatop	2800	Grassland pastures	×			
	Diplazium maximum (D. Don) C. Christ KUP-052 Dip max	Longud	Marsari	2000	Forest floor	×	Areal part	Used as vegetable	0.69
	Gymnocarpium fedtschenkoanum Pojark. KUP-053 Gym fed		Chowkibal	2100	Rock crevice	×			

× (presence of toxicity); √ (absence of toxicity).

3.2. Ecological Knowledge

We found that the local people possessed profound ecological knowledge about fern species, e.g., their habitats and altitudinal distribution. The habitats included forest floors, rock cervices, grass land pastures, moist places, and riparian areas. The highest number of species (45%) was found on the forest floor, followed by rock crevices (26%), grassland pastures (17%), moist places (7%), and riparian zones (5%) (Table 2). This was further

supported by a cluster analysis in which two primary clusters were recorded (Figure 4): Cluster one included the forest floor, comprising species such as, *Asplenium adiantum, Pteridium brownseyi, Dryopteris juxtaposita*, and Cluster two included grass land pastures with species such as *Pteridium revolutum, Dryopteris barbigera, Dryopteris blanfordii*, as well as moist paces with *Asplenium dalhousia* and *Equisetum arvense* and riparian zones harboring *Marsilea minuta* and *Salvinia natans*. Our results are a similar to Bibi et al. [51] from Pakistan, Arjun et al. [54] from Kerala, and Suneetha et al. [55] from Madhya Pradesh.

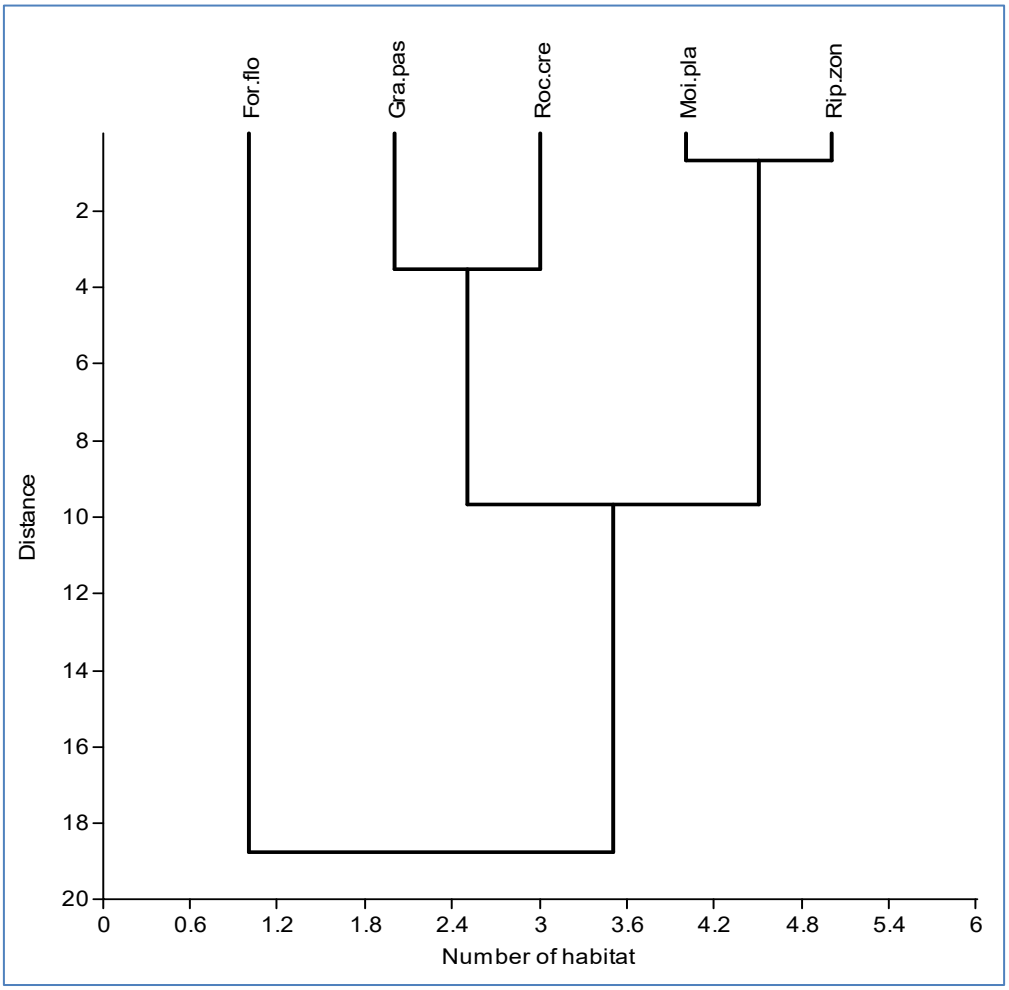

Figure 4. Clustering of documented species in different habitat in the study area.

More than half of the species (56%), including *Pteris cretica, Adiantum tibeticum, Adiantum venustum*, and *Adiantum capillus-veneris*, were reported from altitudes below 2000 m, 19% from 2001–2500 m (e.g., *Asplenium fontanum, Thelypteris microstegia, Deparia japonica, Deparia petersenii*), 17% of the species (e.g., *Athyrium dubium, Lepisorus clathratus*) from 2501–3000 m, and 8% (e.g., *Deparia allantodioides, Dryopteris xanthomelas, Asplenium viride*) from 3001–3500 m (Figure 5). A circular layout of the diagram represents the documented species and altitudinal ranges, and its inner lines represent the relationship between the species and altitude. The lines connecting each species and altitude represent their importance in relation to each other, and the size of the arc reflects the number of species in each category. The histogram illustrates the number of species in the landscape, with the greater species numbers (32) in the lower (below 2000 m) altitudes (Figure 6). When comparing the upper and middle altitudinal regions, the lower areas had higher species numbers. This may be due to the fact that a lower altitude provides diverse, suitable habitats for the growth of pteridophytes.

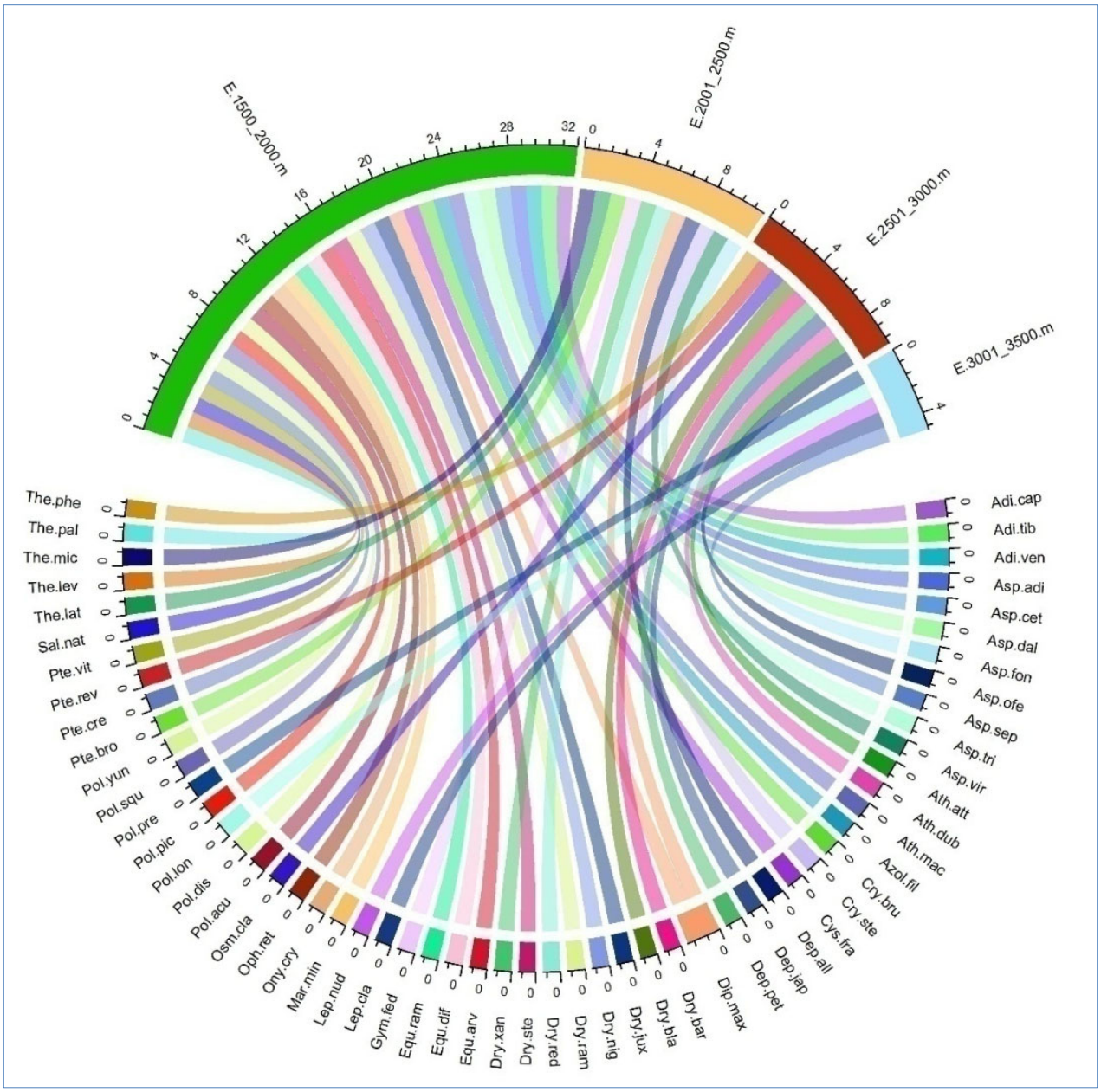

Figure 5. Percentage of species found in different altitudinal groups in the study area. The direction of the lines shows which species is associated with which type of altitudinal group, and the thickness of each bar shows the number of species in each altitudinal type. The complete name of each species is shown in Table 2.

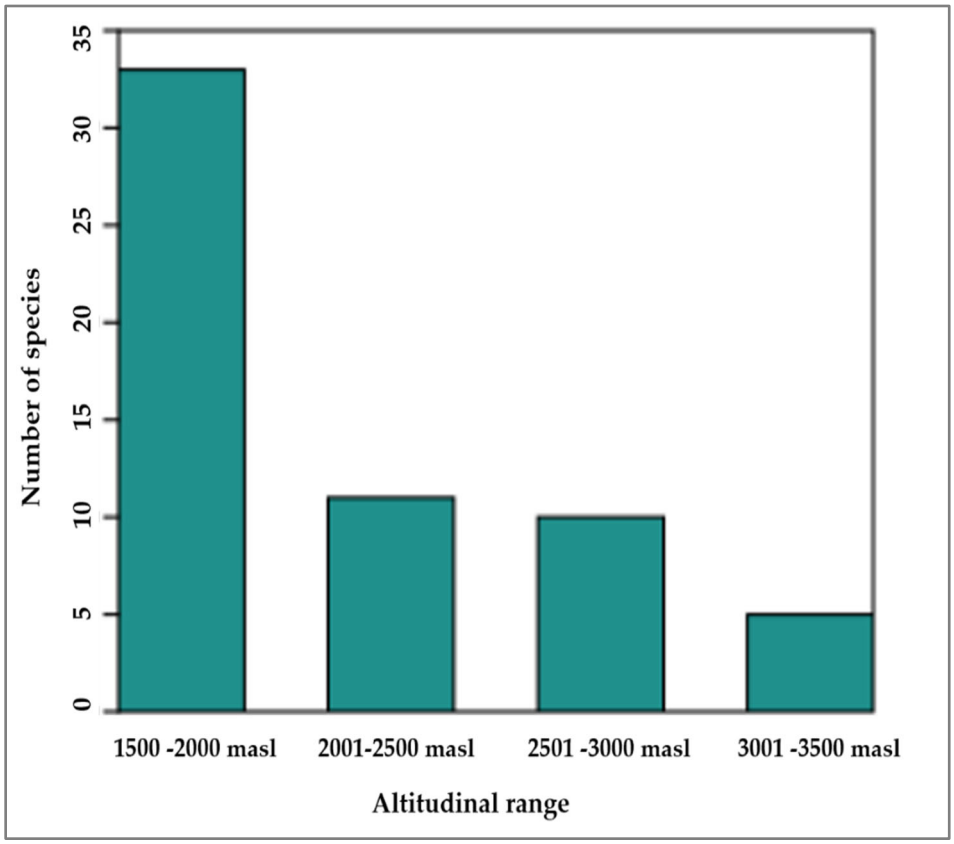

Figure 6. Altitudinal variations of the documented species in the study area.

3.3. Traditional Knowledge

The use of ferns in ethnomedicine has been studied on all inhabited continents, including the Americas and Europe [8]. However, current and updated information on the medical applications offered in Asia and Africa is not easily available. In Asian traditional medicine, pteridophytes are an important category of plants. Mannan et al. [56] Discussed their applications in homeopathic, ayurvedic, tribal, and Unani medicine. Indian pteridophytes have been widely explored for their ethnomedicinal usage [57]. However, no extensive study has been carried out in the Kashmir Himalaya to document the pteridophyte species with ethno-usage.

Among all the documented species (N = 58), only 28 species were recorded for ethno-usage (Table 2). Our results are inline with Sarker et al. [58] reported the ethno-use of pteridophytes from the mensingh district of Bangladesh, Khullar [5] Dehradun, India, and Lie et al. [59,60] from China. We classified the traditional uses into four categories (Medicine, vegetable, oral hygiene and veterinary use) (Figure 7a), among which veterinary use was dominant (N = 9), followed by medicine (N = 8), vegetable (N = 6), and oral hygiene (N = 6) (Figure 5a). Species such as *Dryopteris barbigera, Dryopteris blanfordii, Dryopteris juxtaposita, Dryopteris redactopinnata,* and *Polystichum discretum* were the main species used for ethno-veterinary purposes. The species with medicinal attributions included *Asplenium adiantum-nigrum, Asplenium ceterach* and *Asplenium trichomanes.* For oral hygiene, the species employed were *Asplenium trichomanes, Equisetum arvense,* and *Equisetum diffusum. Pteridium brownseyi, Pteridium revolutum, Dryopteris ramose,* were used as vegetables. According to [61], eating ferns has a 3000-year history in China, and edible ferns are among the most commonly harvested wild food plants in the world, with the stems, rhizomes, leaves, young fronds, and shoots, as well as whole plants, being utilized for food [62]. Although ferns have long been utilized in traditional cuisines, there is a scarcity of knowledge of their usage patterns, nutritional characteristics, and recipes, and generally ferns are rarely

used as a food source, with a few exceptions [56]. It is important to mention that the young fronds of *Pteridium revolutum* and the aerial parts *Dryopteris stewartii* are only eaten when boiled first and then properly sun-dried, because the local users know that if they are taken while green, they may cause cancer and vomiting. The dominance of veterinary usage is because the local people employ the maximum documented species as strays for stables (Figure 7) of the domesticated fauna such as goat, sheep, cow, and buffalo. The complete ethno-usage of the documented species is provided in Table 2.

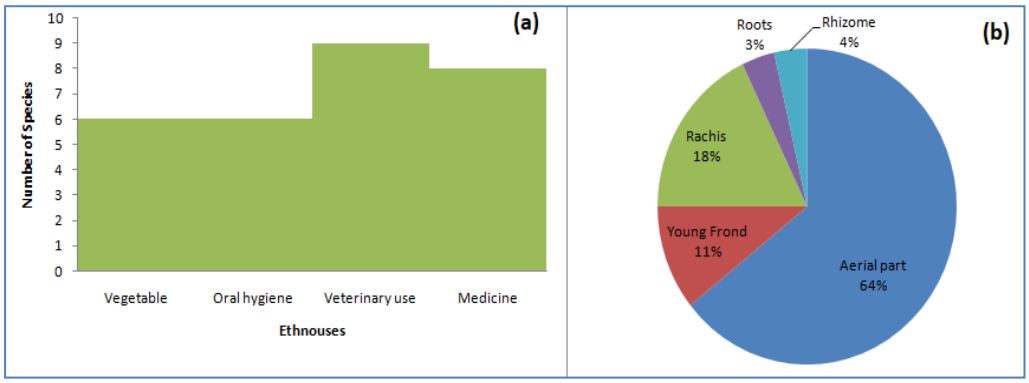

Figure 7. (**a**) Different uses of documented species; (**b**) Percentage of different parts of the documented species for the tradition uses.

The aerial parts of ferns were most commonly used (64%), followed by rachis (18%), young fronds (11%), rhizomes (4%), and roots (3%) (Figure 6b). Giri et al. [61] reported the dominance of aerial parts (the whole plant) in ethno-usage from India; Joshi et al. [63] also reported the dominance of aerial parts (whole plant) from India. The use value ranged between 0.29–0.69 (Table 2): the highest use value was observed for *Diplazium maximum* and the lowest for *Asplenium fontanum*. The high UV value for *Diplazium maximum* was due to its high edible value, with local people consuming it as vegetable. The season for collections runs from March to May, and the collected species is sun dried and made into powder, stored, and used in winters. The local people believed that the species enhances one's life span, explaining its common use. During harsh winters, the availability of green leafy vegetables is sparse, and the price is also very high in local markets, resulting in the dependence of the local people on wild collected vegetables such as *Diplazium maximum*. Further, some tribal people collected the *Diplazium maximum* for commercial purposes. The women from these tribes travel to far off places to sell the collected species and earn decent profits in return. Joshi et al, Shrestha et al. [64,65] reported the commercial value of *Diplazium* species from Central Nepal. *Diplazium* is commonly known as the fiddle head fern, including edible species such as *Diplazium esculentum, Diplazium sammatii,* and *Diplazium proliferum*. The genus is known to have a unique omega 6 fatty acid (di-homo-gammalinolenic acid) as well as polyphenols, suggesting its possible function as a nutraceutical [7]. According to [7], different leafy vegetables such as *Amaranthus, asparagus*, celery, spinach, and lettuce are inferior in nutritional quality to ferns.

3.4. Toxicity

In the present study, the local people indicated that certain potentially poisonous ferns (*Asplenium dalhousia*, *Pteridium brownseyi*, *Pteridium revolutum*, *Dryopteris barbigera*, *Dryopteris blanfordii*, *Dryopteris juxtaposita*, *Dryopteris nigropaleacea*, *Dryopteris ramosa*, *Dryopteris stewartii*, *Athyrium mackinnoniorum*, *Polystichum discretum*, *Polystichum aculeatum*, *Polystichum squarrosum*, *Polystichum lonchitis*, *Polystichum piceopaleaceum*, *Polystichum prescottianum*, and *Polystichum yunnanense*) are not poisonous if harvested at the inappropriate stage. These potentially toxic species constitute 31.03% of the total documented species and are often the cause of livestock deaths. The toxicity of the plant/part can be ascribed to the

alkaloids present at the armature stage.The authorof [66] reported livestock deaths from Indonesia due to plant toxicity.

The existence of rare fern species (*Polystichum aculeatum*, *Pteris vittata*, *Lepisorus nudus*, *Ophioglossum reticulatum*, *Polystichum prescottianum*, *Pteridium brownseyi*, and *Dryopteris juxtaposita*), which were reported for the first time from this part of the Kashmir Himalayas, was one of this study's most intriguing findings. *Polystichum aculeatum* was recently reported from Kashmir Himalayas by [66].

4. Conclusions

The current research is the first comprehensive examination of the ecological and traditional uses of pteridophytes in the study area. We documented 58 pteridophyte species, with Dryopteridaceae being the most common. Most species were found at lower elevations (below 2000m). Among the total number of species reported, 28 species had traditional uses. Veterinary uses were the most common, followed by medical and vegetable uses. *Diplazium maximum* is a highly-edible species that the locals most commonly eat as a vegetable. Due to an ever-changing physical environment, increasing population pressure, and rapid socio-economic growth, all of these species and their related traditional knowledge are endangered. Since much of the information is still in the hands of the local community without any written documentation, the collection and documentation of such information is critical. Ethnopteridological knowledge needs to be efficiently collected, conserved, and used to benefit the country's development and conservation.

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