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RESEARCH ARTICLE

Floristic composition and biological spectrum of the flora of Shishikoh valley, district Chitral, Pakistan

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Abstract

In the present study, a total of 329 vascular plant taxa, encompassing 215 genera and 71 families across three major plant groups-Pteridophytes, Gymnosperms and Angiosperms were recorded from the Shishikoh Valley in District Chitral, Pakistan. Among these, 165 species belonging to 19 families were identified as new additions to the known flora of the Shishikoh Valley, District Chitral, Pakistan. Nine endemic taxa were recorded for the first time from the study area. The dominant family was Asteraceae with 32 taxa (9.73 %), followed by Lamiaceae with 31 taxa (9.42 %) and Papilionaceae with 29 taxa (8.81 %). In terms of leaf persistence, deciduous plants were represented by 305 taxa (92.71 %), followed by perennials with 19 taxa (5.78 %) and aphyllous plants with three taxa (0.91 %). Mesophytes with 304 taxa (92.4 %) were the most dominant plants, followed by xerophytes with 22 taxa (6.69 %) and hydrophytes with three taxa (0.91 %). The recorded flora consists of 46.2 % annual herbaceous plants and 28.88 % perennials. Therophytes and hemicryptophytes were the most frequent life forms in the area. The discovery of new plant species in the area underscores the importance of continued botanical surveys and detailed documentation, which would be beneficial in adding many new species to the flora of District Chitral, Pakistan.

Keywords: angiosperm; endemic; flora; life form; new records

Introduction

The floristic and ecological diversity of plant taxa depend on their geography, climate, physiography, elevation and habitat. A favorable climate supports rich floristic and ecological diversity within a given area. The listing of plant taxa in a specific geographical area is a basic need for their ecological management (1). The floristic composition of a region is changeable with passage of time due to elevation, humidity and rainfall (2, 3). The floral diversity in some areas consists of all taxa within a specific geographical region, characterized by distinct ecological and geological conditions (4). Floristic diversity of any region is the sum of the species within a specific boundary, either wild species or cultivated species, which reflects plant resources. These resources are affected by anthropogenic activities, agricultural practices, overgrazing and natural disasters (5). The Himalayan and Hindukush Mountain ranges in Pakistan, covering an area of approximately 3500 km^2, are home to around 60 eco-regions, 488 zones and four biodiversity hotspots. This region harbors exceptional floristic richness, with about 10700 plant taxa, including 2500 endemic species (6). Globally, around 414000 flowering plant species have been identified so far, with Pakistan accounting for approximately 6000 species across more

than 200 plant families (7). Of the total, 80 % of Pakistan's endemic flowering plants are reported to be found in the northern area and western mountains (8). However, a comprehensive and universally accepted checklist, such as a global "World Flora," is still lacking (9). Studies have been carried out in the past from different areas of Pakistan but due to the climate change the structure of diversity is changeable (10). Chitral District is unique among all and considered the richest floristic region by hosting 1500 flowering plant species and 67 endemic taxa (11-16). According to the available literature, there are no prior comprehensive reports on the flora of the Shishikoh Valley. This highlights the region's diverse climatic conditions and emphasizes the need for further floristic research to address existing knowledge gaps. The primary objectives of the present study are to assess the floristic composition and ecological characteristics of the plant species found in the rural region of Shishikoh, District Chitral, Pakistan, with a focus on the following goals:

- To develop a comprehensive checklist of the flora in the study area.
- To collect, identify and document both cultivated and wild plant taxa present in the region.

Materials and Methods

Study area

This study was carried out in the Shishikoh Valley (35° 55' 52" N, 71° 50' 03" E), located in the Chitral District of Khyber Pakhtunkhwa, Pakistan (Fig. 1). The valley has unique geographical setting, characterized by its distinct ecosystem and geological features, supports a diverse flora comprising all plant taxa native to the region Furthermore, the area is not only a single steep ridge, but also a successive series of mountain ranges stretching in a series of fluctuating elevations from 1300 m to 4000 m, cut by deep valleys extending over several kilometers along an uneven north axis. The Hindukush Mountain range covers about 565.86 km^2 and is located between 1420 m and 4200 m. The valley is bordered by Golen in the West, Laspur to the north, the Dir district to the East and Drosh lies towards the south. The climate is fluctuating; July and August are the hottest months, with temperatures reaching above 37 ˚C, while December to February are the coldest months, with temperatures reaching below -10 ˚C (17).

Floristic research

An extensive and detailed literature review was conducted in Shishikoh Valley regarding geological and medicinal flora background. Based on this information, a field investigation was made in different seasons from April 2020 to September 2021. Habitat, life form, zones, habit, altitudinal range, threats and degradation of habitat were observed. Systematic exploration was conducted across all over the area. Field trips were planned to study all 13 selected localities (villages and mountains) to obtain all plant species across the selected study area. All the specimens were collected through standard procedure from various zones such as residential zone, river zone and cultivated field, stony slope zone, mixed vegetation zone, dry stream zone, juniper steep zone, sub-alpine zone and alpine zone. The collected data include Specimens numbers, flowering season, occurrence, habitat; zones cultivation status of plants and all the important information about plants were documented in field notebook on the spots. The collected plant species were properly pressed, dried out and well preserved according to the standard technique (18). After that identification were carried out and named according to the available literatures (11-20) and along with the updated version (21). A floristic list was arranged by classifying plant species alphabetically order. Finally, all the plant specimens were deposited at the Herbarium of Hazara University, Mansehra, Pakistan (HUP).

Data analysis

Handheld GPS was used to determine the altitude, latitude and longitude of all sites of the localities. Table was prepared based on data collection during field work about species distribution, zone, habitat, habit, life form, from various localities and different values were used to create graph (Table 1 and 2).

Results

Family importance values (FIV)

In current study a total of 329 plant taxa belonging to 215 genera and 71 families were reported, which establishing a baseline for

Table 1. Localities showing the sampling sites with their coordinates, population and elevation

Location	Coordinates		Population	Elevation (m)
	Longitude	Latitude		
Birga	71° 62’ 20.73”E	35° 44’12.13”N	1306	2250
Birga Nisar	71° 60’ 18.55”E	35° 41 ’5.25”N	251	1800
Gauch	71° 59’ 16.50”E	35° 40’ 05.17”N	660	1580
Goren	71° 62’ 17.51”E	35° 42’ 05.09”N	895	1597
H.Begandeh	71° 83’ 3.17”E	35° 59’ 84.1.”N	560	1457
Kalas	71° 67’ 12.42”E	35° 47’ 16.02”N	213	1959
Kashendel	71° 66’ 15.22”E	35° 46’ 15.02”N	618	1829
Kotek	71° 56’ 17.27”E	35° 47’ 14.61”N	330	2114
Tangal Gol	71° 55’ 11.57”E	35° 44’ 08.08”N	215	3600
Madaklasht	71° 57’ 94.71”E	35° 48’ 16.09”N	2744	2130
Muzhdeh	71°53’ 13.61” E	35° 39’ 02.03”N	351	1475
Law hill	71°58’ 17.58”E	35° 41’ 05.61” N	45	3500
Shishi	71° 83’ 3.10” E	35° 59’ 84.01” N	949	1310

Table 2. Taxonomic account of floristic diversity of various group of plants of Shishikoh valley, district Chitral, Pakistan

Taxanomic group	Families	Genera	Species	Herb	Shrub	Trees
Angiosperms	63	202	309	237	37	36
Gymnosperms	3	6	11	-	2	9
Pteridophytes	5	7	9	9	-	-
Total	71	215	329	246	39	45

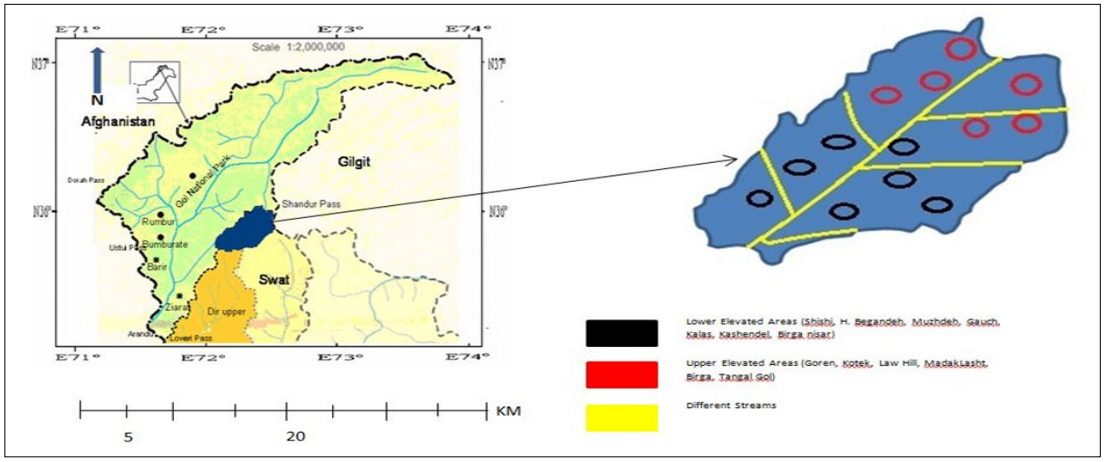

Fig 1. Map of the study area of Shishikoh valley, District Chitral, Pakistan.

the flora of Shishikoh Valley, District Chitral, Pakistan. The leading family was Asteraceae with 32 taxa (9.73 %), followed by Lamiaceae with 31 taxa (9.42 %, Papilionaceae with 29 taxa (8.81 %), Rosaceae with 17 taxa (5.17 %), Apiaceae with 15 taxa (4.56 %), Brassicaceae with 14 taxa (4.26 %), Polygonaceae with 13 taxa (3.95 %), Boraginaceae with 10 taxa (3.04 %), Cupressaceae, Ranunculaceae with 9 taxa (2.74 %) each, Caryophylaceae with 8 taxa (2.43 %), Chenopodiaceae and Poaceae with 7 taxa(2.13 %) each, Amaranthaceae, Plantaginaceae and Salicaceae with 6 taxa (1.82 %) each, Primulaceae, Solanaceae and Apocynaceae with 5 taxa (1.52 %), Alliaceae, Euphorbiaceae, Papavaraceae and Schrophulariaceae with 4 taxa (1.22 %) each. The remaining 7 families comprise 3 taxa (0.91 %) each, 15 families with 2 taxa (0.61 %) each and the remaining 26 families were with single taxa (0.30 %) (Table 2 & Fig. 2).

Life form

Therophytes were dominant with 115 taxa (34.95 %), followed by hemicryptophytes with 100 taxa (30.40 %), chameophytes with 47 taxa (14.29 %), phanerophytes with 45 taxa (13.68 %), geophytes with 18 taxa (5.47 %) and cryptophyte showed minimum four taxa (1.22 %) (Fig. 3, Supplementary Table 1).

Habit and cultivation statues

Habit-wise, 152 species (46.20 %) were annual herbs, 95 (28.88 %) species were perennial herbs, 37 species (11.24 %) were shrubs, 36 (10.94 %) were trees and 9 (2.75 %) species were biennial herbs. 245 taxa (66.46 %) were reported as wild and 84 taxa (25.53 %) as cultivated (Fig. 4, Table 2).

Genera Value (GV)

For the dominancy of specific genera within the region the GV was noted by the number of species. The leading genera were *Nepeta* with 8 taxa (3.72 %), followed by *Rumex* with 6 taxa (2.79 %), *Chenopodium*, *Trifolium* and *Prunus* with 5 taxa (2.33 %) each, *Artemisia, Mentha, Rosa and Salix* with 4 taxa (1.86 %) each, 16 genera have 3 taxa (1.40 %) each, 38 genera with 2 taxa (0.93 %) each and 150 genera were monotypic with (0.47 %) each.

Leaf persistence and Habitat

Out of the total 304 taxa (92.4 %) were deciduous, 22 taxa (6.69 %) were evergreen and 3 taxa (0.91 %) were aphyllous. Habitat-wise, mesophytes had 160 taxa (48.63 %), xerophytes had 147 taxa (44.68 %) and hydrophytes had 22 taxa (6.69 %).

Zones

The study revealed distinct floristic patterns correlated with elevation, ranging from 1310 m to 3600 m. The cultivated field zone (1457-2130 m) showed peak diversity with 79 taxa (24.01 %), particularly at mid-elevation sites (1580-2130 m). Residential areas (1475-1959 m) supported 60 taxa (18.24 %), while subalpine (2114-2250 m) and alpine zones (3500-3600 m)

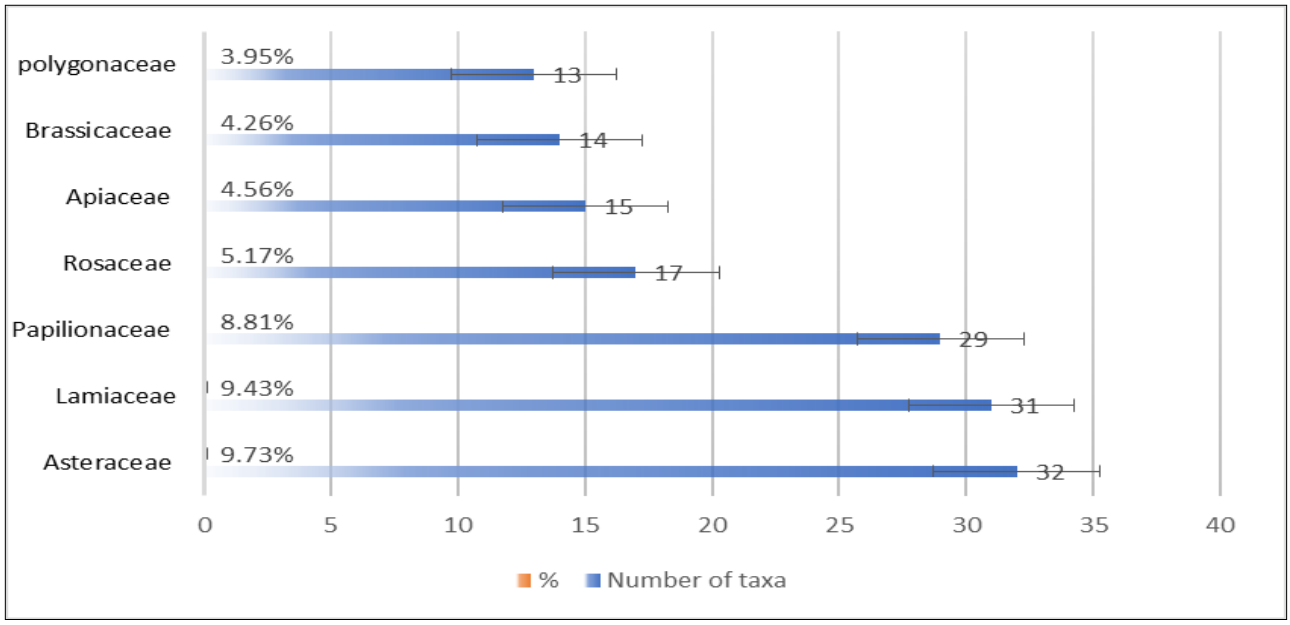

Fig. 2. Histogram of the floristic composition of the of the presented families in Shishikoh valley.

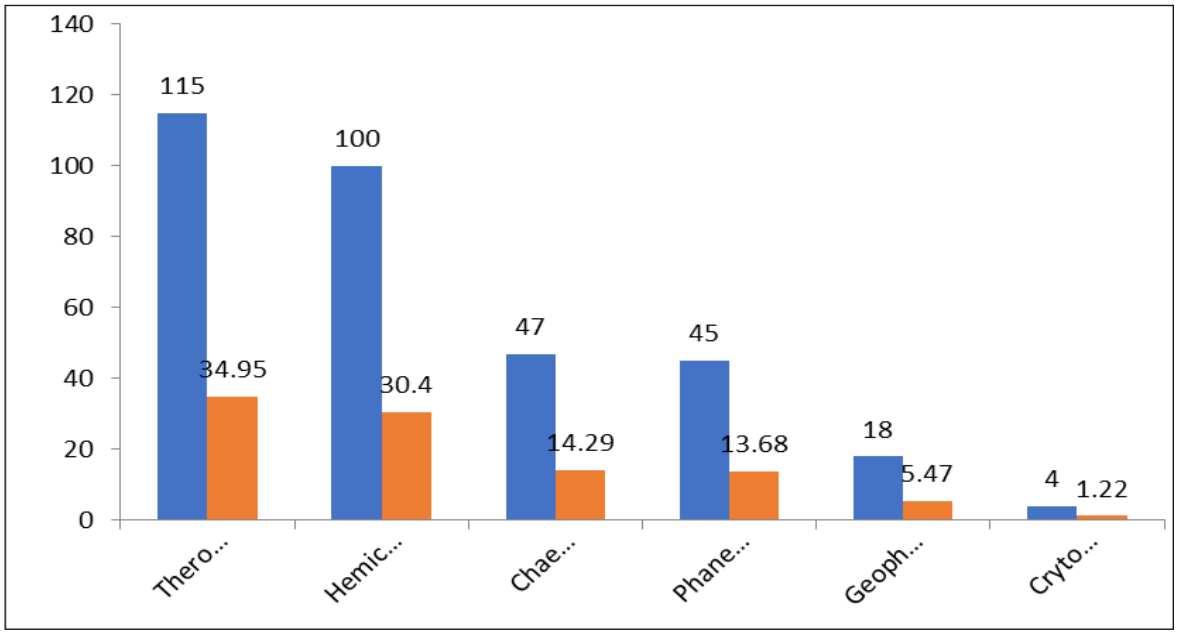

Fig. 3. Life form spectrum of flora in Shishikoh valley, District Chitral, Pakistan.

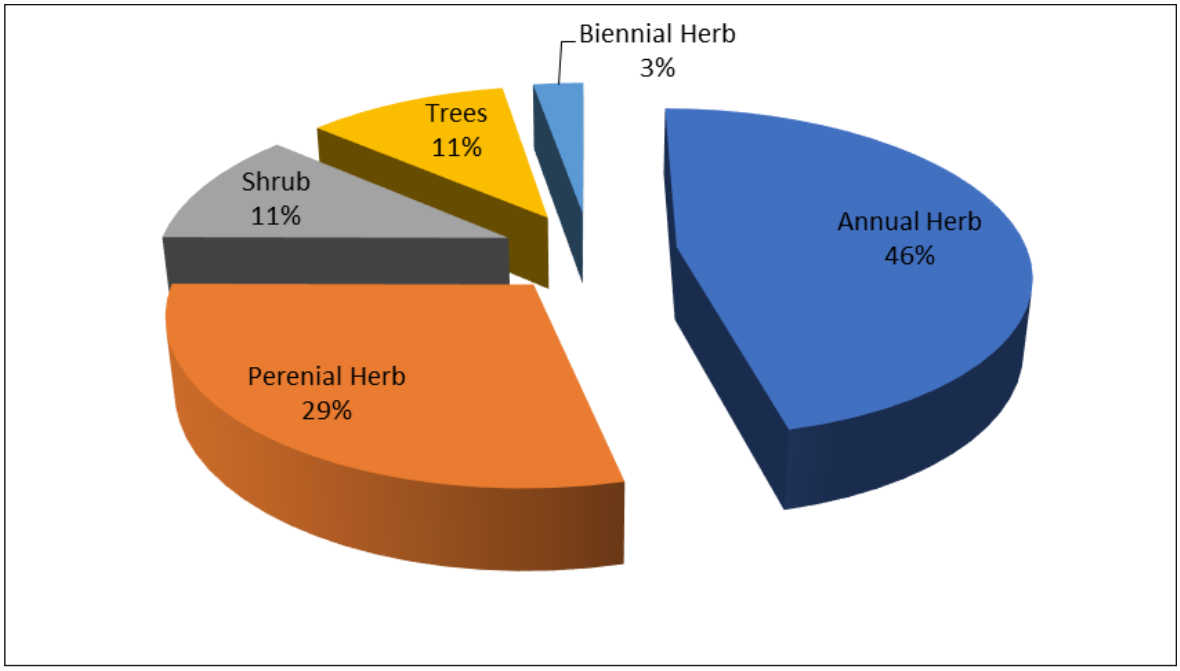

Fig. 4. Life Form of plant taxa from Shishikoh Valley, District Chitral, Pakistan.

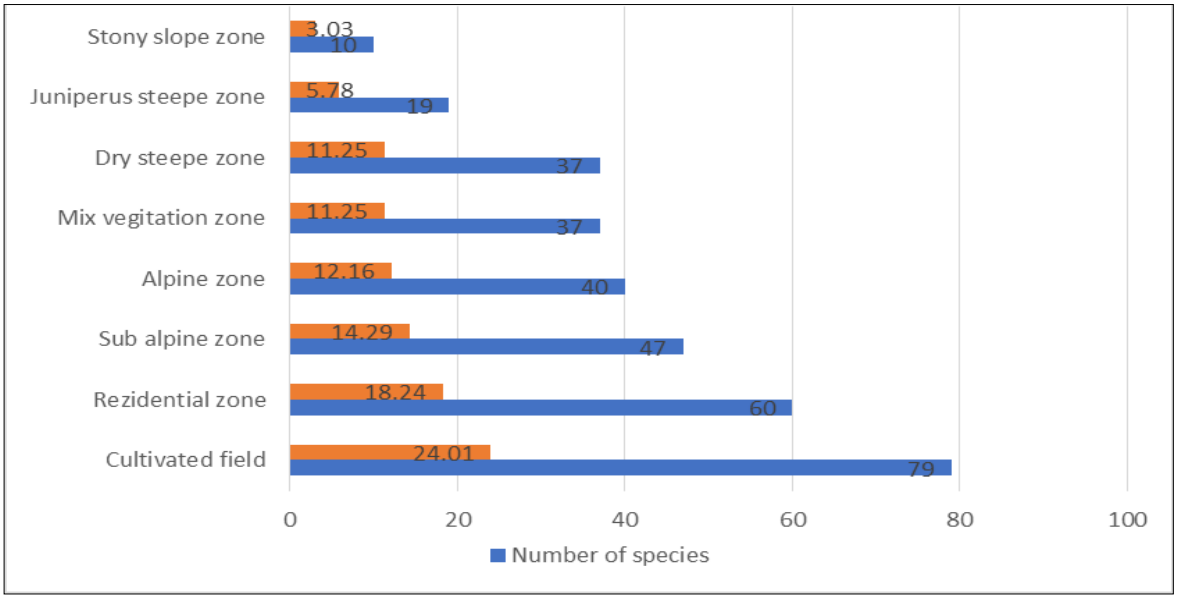

Fig. 5. Presence of the plants in different zone in Shishikoh valley, Chitral district.

contained 47 (14.29 %) and 40 taxa (12.15 %) respectively. Lower elevations (1310-1597 m) in mixed vegetation and dry stream zones each hosted 37 taxa (11.25 %). The Juniperus steep zone (1829 m) and stony slopes (1597-1959 m) showed reduced diversity with 19 (5.78 %) and 10 taxa (3.04 %), reflecting harsher growing conditions at these transitional elevations (Fig. 5 & Supplementary Table 1).

Endemic taxa

The study area harbored several endemic plant species, including *Anaphalis chitralensis* Qaiser & Abid and*rosace staintonii* Y.J.Nasir, *Astragalus chitralensis* S.M.Ali, *Daraba pakistanica* Jafri, *Draba oleoides* subsp. *chitralensis* Regel & Schmalh., *Delphinium chitralense* H.Riedl, *Seriphidium chitralense* (Podlech) Y.R.Ling, *Myosotis refracta* subsp. *Chitralica* Kazmi, *Onosma chitralicum* I.M.Johnst. and *Rhodiola tibetica* (Hook.f. & Thomson) S.H.Fu. These taxa represent unique components of the region's biodiversity and underscore the phytogeographical significance of Shishikoh Valley.

Threats

Among the reported species the threats were also noted for each species faced difficulties to survival by facing different type of major threats i.e. over grazing effect 78 taxa (23.71 %), fuel wood 35 taxa (10.64 %), flood 57 taxa (17.33 %), landslide 35 taxa (10.64 %), soil erosion 30 taxa (9.12 %), medicinal uses 43 taxa (10.07 %), road extension 27 taxa (8.21 %) and deforestation 15 taxa (4.56 %) and remaining 9 plants taxa did not have any threats (Supplementary Table 3).

Discussion

Floristic composition

The ecological characteristics of an area are shaped not only by its floristic diversity, including both wild and cultivated species, but also by species composition, community structure, abiotic conditions such as climate and soil, species interactions and key ecological processes like nutrient cycling and disturbance regimes. The floral diversity of Shishikoh valley is rich, comprising several valuable plant taxa. After thoroughly survey 329 plant taxa belonged to 215 genera and 71 families were recorded. These species were further categorized into three major plant groups such as Pteridophytes, Gymnosperms and Angiosperms. Based on the number of families and genera the lowest division was Pteridophytes with 5 families and 7 genera, Gymnosperms is the next group with 3 Families, 6 genera and 11 species and the largest reported group was Angiosperm with 63 families, 202 genera and 309 species from Shishikoh valley. Previously, adjacent to area, plant species from Shigar Valley, Karakorum Mountain and also 372 vascular plants with 224 genera and 67 families into Pteridophytes, Gymnosperms and Angiosperms as in similar order to our results with same as our study lowest and highest divisions was reported earlier (22). Like that the same results in family wise distribution of his reported plants in former studies (23). The result is compared to the floristic composition of different hotspot regions in Pakistan, the species numbers recorded show diversification (24-26) mainly due to the presence of a different environment in these rising and falling mountain series cut by deep valleys, making a diverse number of habitats each with certain topographies concerning soil composition, topographical differences, resources of water and urbanization events. Similar result as we have mentioned that Asteraceae was dominant family followed by Lamiaceae, Papilionaceae, Rosaceae, Apiaceae and Brassicaceae (27-30). Asteraceae and Lamiaceae were leading families next by Rosaceae in Chitral region (31). Similarly, these families in the flora of Pakistan due their unique phytogeographical position (32). The previous studies reported an updated checklist of plant species and reported Asteraceae as the leading family followed by Lamiaceae at Kotli District Jammu and Kashmir (33). A similar work was reported previous studies that the species diversity, cover and frequency of Mount Elum Pakistan and reported 124 species distributed in 52 Families (34). Some literature also indicated similar result in Flora of Pakistan (12, 22, 35). Similarly, (36) documented similar studies from Ayubia National Park, district Abbottabad and (37, 38) reported similar results as we have studied. Similarly, (39, 40) mentioned Asteraceae as leading family.

Life form spectra

The floristic and ecological investigation of previous studies (41) identified therophytes as the predominant life form, followed by hemicryptophytes, indicating a vegetation structure adapted to the region's environmental conditions. Previously, Similar data were reported according to results the therophytes were dominant life form according to the results of previous studies (42). Therophytes are a well-adapted life form. Moreover, therophytes are famine evaders in the sense that the whole plant is shed during the unfavourable conditions (43). The floristic composition where the biological spectrum and phenological pattern of vegetation in the subtropical forest of Kotli District, Azad Jammu and Kashmir, Pakistan was reported as same as our results with dominant factors (44). The biological spectrum analysis revealed a predominance of therophytes, with hemicryptophytes as the secondary dominant life form, reflecting the area's adaptive vegetation patterns. Previously studied biological spectra of vegetation of Sathan Gali, district Mansehra, Pakistan and identified 105 plant species with 55 families; the leading life form was therophytes (45) . Biological spectra change due to biotic influences like agricultural practices, grazing, deforestation, trampling, temperature revision and climatic change (46). Similarly, former researchers floristically studied the elevated region of Deosai Plateau, the Himalayas. However, the resulting data indicated that the dominant life form was hemicryptophytes (47). Former studies also pointed out that life form and index of similarity from Sarsawa hills, District Kotli where also the leading biological spectrum was therophytes (48). The significance of this research is the addition of new species to the flora of Shishikoh valley, district Chitral, Pakistan, while the surrounding region needs further thorough exploration and documentation of botanical resources that would add novel species to the flora of Pakistan.

Conclusion

The present study documented 329 plant taxa representing 215 genera and 71 families in Shishikoh Valley, District Chitral, Pakistan, revealing significant floristic diversity in the region. The taxa were divided into three major plant groups, such as Pteridophytes with 5 families, 7 genera and 9 species,

Gymnosperms with 3 families, 6 genera and 11 species and Angiosperms with 63 families, 202 genera and 309 species. The leading families were Asteraceae with 32 taxa (9.73 %), Lamiaceae with 31 taxa (9.42 %), followed by Papilionaceae with 29 taxa (8.81 %), Rosaceae with 17 taxa (5.17 %), Apiaceae with 15 taxa (4.56 %), Brassicaceae with 14 taxa (4.26 %), Polygonaceae with 13 taxa (3.95 %), Boraginaceae with 10 taxa (3.04 %). The area is a hub of vegetation but lacks care in the current generation. The community wiped out much of the flora of the area. It is an urgent need to generate awareness about the importance of plant taxa among the community so that people can conserve plant wealth. The endemic taxa were *Astragalus chitralensis androsace staintonii, Anaphalis chitralensis*, *Delphinium chitralense, Daraba pakistanica, Onosma chitralicum, Rhodiola tibetica* and *Seriphidium chitralense*. The threats such as over grazing, over utilization of plants as fuel, road extension, landslides, medicinal uses, habitat degradation and deforestation, should be controlled. These threats showed visible biotic pressure which strictly threatened the flora from Shishi to Madaklasht. It is expected that this revision will provide useful baseline information about floral diversity of the area. Anthropogenic activities should be controlled and conservation strategies should be adopted for protection of plant communities.

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Authors' contributions

KU designed the study conception and framework, MI performed the experimental research, FU interpreted the results and drafted the manuscript. JS encouraged the first author to conceive the presented idea. MS and RZ contributed to the research design and findings of this work. SK^1 and SK^2 performed data analysis, MW revised the manuscript, RZD, ZA and TA helped in funding. All authors read and approved the final manuscript (SK^1- Saeed Khalil, SK^2- Shazia Khatoon).

Compliance with ethical standards

Conflict of interest: The authors declare that they have no known competing financial interest or personal relationships that could have appeared to influence the work reported in this paper.

Ethical issues: None

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