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Research Article

Diversity and Distribution of Endemic Flora in Pakistan

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Abstract: The objective of the current research is to provide a systematic account of the variety of endemic plant species found in Pakistan, with a focus on family, distribution, and life form status. The existing research effort, which is based on a survey of the literature, field observations, and herbarium records, has identified 306 endemic plant species among 50 genera and 40 families. In accordance with an analysis of the life form or status of these plant species, herbs are dominant (n= 243 species, 80 %), while shrubs (n= 33 species, 11 %), under shrubs (n= 13 species, 4 %), trees (n= 10 species, 4 %), and grasses (n= 7 species, 2 %). The study revealed that Asteraceae is the most dominant family (n= 38 species), while *Taraxacum* is a dominant genus (n= 23 species). Distribution analysis revealed that the majority of species are distributed in mountainous areas of Pakistan. Khyber Pakhtunkhwa province is rich in endemism (n= 142 species, 37 %). The current study sheds light on Pakistan's endemism situation. Further research that takes into consideration population levels and new risks is also required. The study will help policymakers in developing conservation strategies.

Keywords: Endemic, Species Distribution, Diversity, Conservation

1. INTRODUCTION

The word endemic was introduced by De Candolle in 1820, who adapted its meaning as a sickness that constantly occurs within an area, describing genre end'emiques as essentially analogous to a taxon that is limited to a particular area [1]. As an antonym to endemic taxa, species having a wide distribution were termed genres sporadiques [2]. Even though the phrase was first used in a biogeographic context, its regular use within the scientific community began in the early twentieth century, when it was used in books and journals to portray new species with limited transmission or to refer to threat classifications [3]. As the name implies, endemic plants are those with narrow distributions, low population sizes, and habitat specificity [3, 4].

An astonishing diversity of flora exists in Pakistan, a land of breath-taking beauty and rich culture. Throughout the country, over 7,000 vascular plants thrive, each as unique as the landscapes in which they are found, from the towering peaks of the Himalayas to the scorching sands of the Thar Desert [5]. A rich diversity of flora can be found in the Himalayan region, including conifers, alpine flowers, and rhododendron forests. [6, 7]. Many endemic and rare species are found in the mountainous areas in the north and west, which are significantly more numerous here than in other similar-sized countries [8, 9]. A wide variety of plant and animal life thrives in the fertile farmlands, lush forests, and river deltas of the Indus Valley. A unique and fascinating flora can also be found in the deserts of Pakistan, including hardy succulent species that have adapted to the harsh conditions of the desert. Additionally, the coastal areas of the country are rich in plant species that have adapted to the harsh coastal environment, including mangrove forests and salt-tolerant species [10].

Chaudhri & Qureshi [11] created a checklist of 707 uncommon and endangered plant taxa, which also includes some endemic plant species, based on the frequency of herbarium specimens and observations recorded in the flora of Pakistan. This list may undoubtedly be considered a great contribution, but it also strongly encourages researchers to gather more field data to back their findings. As a follow-up, some of the important studies that describe the assessments of the conservation status of different plant species are

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available in the literature [10, 12]. Many other researchers also reported endemics (*Pimpinella stewartii, Otostegia limbata, Aquilegia nivalis*) ranges [13-17]. All these reports merely represent 5 % of the endemic flora of Pakistan. But no systematic attempt has ever been made to understand a list of endemic species and the state of their dispersion.

Several projections predict that we are on the verge of experiencing the sixth major extinction. Plant species are disappearing at a rate of up to one every day [18]. A key contributor to the losses is anthropogenic activity that continuously alters the environment and fragments and destroys it. Climate change is another related factor [19].

To conserve species that are critically endangered, first, we must identify them. Endemic species require special care since they are in grave danger [20]. However, there aren't many studies that have mapped the spread of various plant species [21, 22]. Therefore, present study aimed to enumerate the diversity and occurrence of endemic flora of Pakistan. Additionally, this study will aid decision-makers in creating conservation and management strategies.

2. MATERIALS AND METHODS

2.1 Study area

Pakistan represents a number of the world's biological areas due to its large altitudinal range and broad latitudinal dispersion (Fig. 1), which spans around 1400 km from the seashore in the south to snow-capped mountains in the north. Pakistan is home to three of the world's eight biographic realms, including the Indo-Malayan, Palaearctic, and Afro-tropical, as well as four of the world's ten biomes, including the desert, temperate grassland, tropical seasonal forest, and mountains, all of

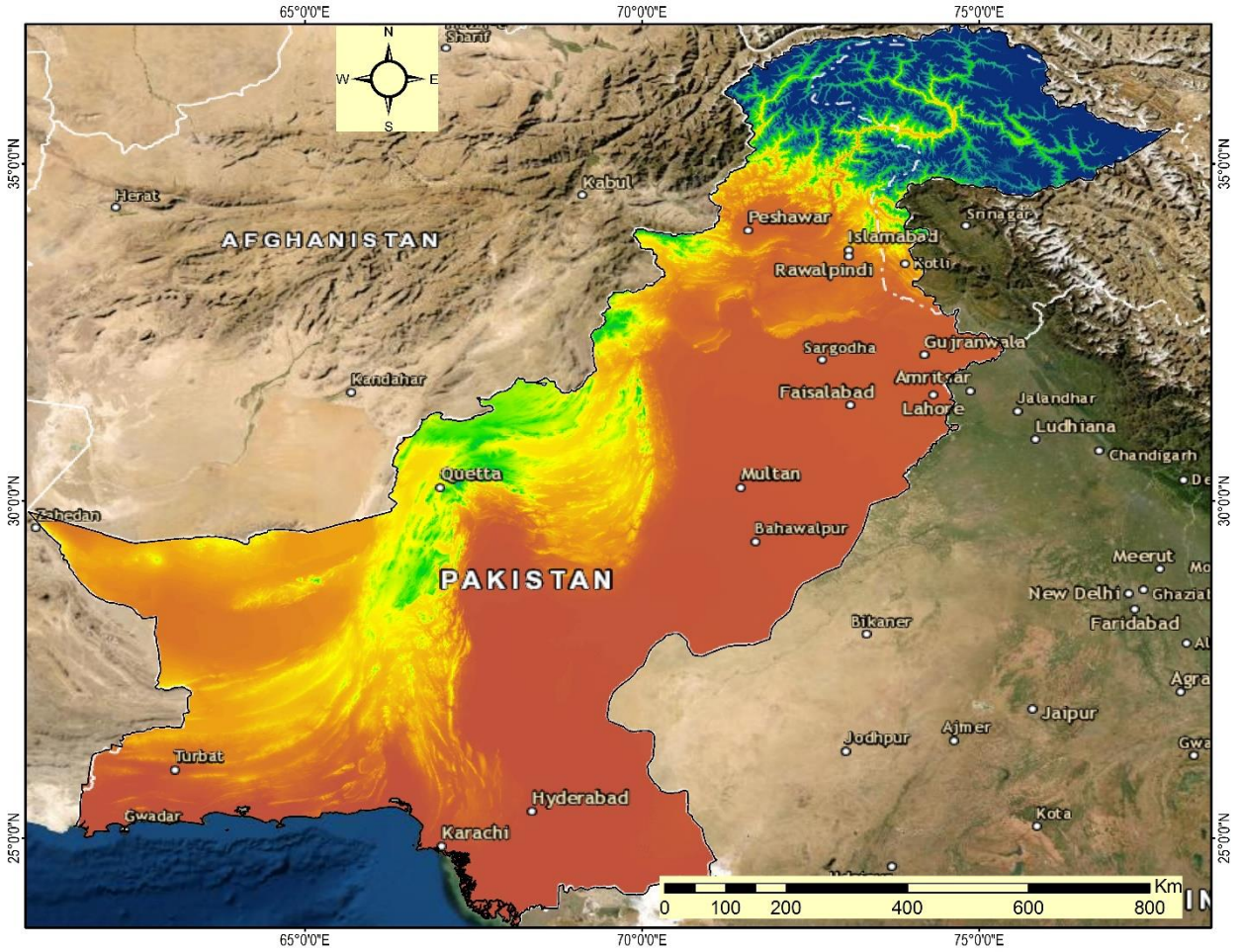

Fig. 1. Map illustrating the study area.

which are home to a variety of ecosystems [23]. There have been reports of about 6,000 flowering plant species, including both indigenous and alien varieties. The area has distinct seasons with notable temperature changes. Although there are occasional windy spells in the summer, the winds are often from the north or south-east throughout the year. In the area, there are two different seasons for rainfall: summer (July to September), and winter (December to March) [24].

2.2 Data Collection

The list of Pakistan's endemic plant species was compiled using Flora of Pakistan (www.efloras.org), Flora of Iranica, and the published literature [11, 25-28]. This resulted in 580 species that were endemic to Pakistan. After removing duplicates, the distribution ranges of each species were validated and cross-checked using online resources of www.theplantlist.com, www.powo.science.kew.org, and the Global Biodiversity Information Facility (GBIF). Synonyms were excluded and only species with accepted names and having occurrences records from Pakistan were included in the list resulting in finding 306 species to be endemic to Pakistan. Several sources were used to gather existing occurrence records (the latitude and longitude) of endemic plant species in Pakistan. These sources include our field surveys in 2018-2021, herbarium sheets, www.inaturalist.org, and www.gbif.org. The species were classified on the basis of herbs, shrubs, under-shrubs, trees and grasses. The accepted endemic plant species of Pakistan in the current study are arranged alphabetically in tabular form followed by family, distribution, habitat life form and flowering period shown in **(Table 1)**.

Table 1. A comprehensive list of Plant species endemic to Pakistan.

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
1	*Abutilon alii*	Malvaceae	Lasbela	Shrub	July-Aug
2	*Abutilon ghafoorianum Abedin*	Malvaceae	Sahiwal	Undershrub	July-Aug
3	*Abutilon karachianum S.A. Husain & Baquar*	Malvaceae	Karachi	Herb	July-Aug
4	*Abutilon pakistanicum Jafri & Ali*	Malvaceae	Sindh	Undershrub	July-Aug
5	*Abutilon sepalum S.A.Husain & Baquar*	Malvaceae	Sindh	Herb	July-Aug
6	*Achillea millefolium subsp. Chitralensis*	Asteraceae	Chitral	Herb	May-June
7	*Aconitum curvipilum Riedl*	Ranunculaceae	Chitral	Herb	July-Aug
8	*Aconitum heterophyllum var. bracteatum*	Ranunculaceae	Hazara	Herb	July-Aug
9	*Aegopodium burttii E. Nasir*	Umbelliferae	Hazara	Herb	June-July
10	*Allium balochistanicum Wendelbo*	Alliaceae	Balochistan	Herb	May-June
11	*Anaphalis staintonii*	Asteraceae	Chitral, Kashmir	Undershrub	June-Sep
12	*Androsace hazarica R.R. Stewart*	Primulaceae	Hazara	Herb	July-Aug
13	*Androsace lowariensis Y. Nasir*	Primulaceae	Chitral	Herb	June-Sep
14	*Androsace ojhorensis Y. Nasir*	Primulaceae	Chitral	Herb	June
15	*Androsace staintonii Y. Nasir*	Primulaceae	Chitral	Herb	June
16	*Anemone falconeri Thoms*	Ranunculaceae	Pak & Kashmir	Herb	May-June
17	*Anemone obtusiloba var. potentilloides*	Ranunculaceae	Pak & Kashmir	Herb	May-June
18	*Anemone tetraSepala Royle*	Ranunculaceae	Pak & Kashmir	Herb	July-Aug
19	*Aquilegia fragrans var. fragrans*	Ranunculaceae	Chitral	Herb	July-Aug
20	*Aquilegia nivalis Falc. ex Baker*	Ranunculaceae	Pak & Kashmir	Herb	June-July
21	*Aralia cachemirica Dcne*	Araliaceae	Kashmir	Herb	June-Oct
22	*Artemisia amygdalina Decne*	Asteraceae	KP & Kashmir	Herb	July-Sep
23	*Asparagus dumosus Baker*	Asparagaceae	Sindh & Balochistan	Undershrub	March-Aug
24	*Asparagus gharoensis Blatter*	Asparagaceae	Sindh	Shrub	March-Aug
25	*Astragalus affghanus Boiss*	Papilionaceae	Chitral, Balochistan	Herb	Mar-April
26	*Astragalus auganus Bunge*	Papilionaceae	Balochistan	Herb	March
27	*Astragalus concretus Benth*	Papilionaceae	Kashmir	Herb	July-Aug

Table 1 Continued...

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
28	*Astragalus falconeri Bunge*	Papilionaceae	Chitral	Herb	July-Sep
29	*Astragalus flemingii Ali*	Papilionaceae	Punjab	Herb	March
30	*Astragalus Gilgitensis.ensis Ali*	Papilionaceae	G.B.	Herb	July
31	*Astragalus hostilis Boiss*	Papilionaceae	Balochistan	Undershrub	April-June
32	*Astragalus lamondiae Deml*	Papilionaceae	Balochistan	Herb	April
33	*Astragalus maxwellii Royle*	Papilionaceae	Kashmir	Herb	June-July
34	*Astragalus nicharensis Bunge*	Papilionaceae	Balochistan	Herb	June-July
35	*Astragalus oihorensis Ali*	Papilionaceae	KP	Herb	June
36	*Astragalus sultani Ali*	Papilionaceae	Balochistan	Herb	April
37	*Astragalus toppinianus Ali*	Papilionaceae	Chitral	Herb	May-July
38	*Atriplex stocksii Boiss*	Amaranthaceae	Balochistan	Shrub	Dec-Jan
39	*Berberis balochistanica*	Berberidaceae	Balochistan	Shrub	Mar-May
40	*Berberis brevissima Jafri*	Berberidaceae	KP	Shrub	Mar-May
41	*Berberis huegeliana Schneid*	Berberidaceae	Kashmir	Shrub	April-July
42	*Berberis kashmirana Ahrendt*	Berberidaceae	Kashmir	Shrub	June-July
43	*Berberis parkeriana Schneid*	Berberidaceae	Hazara, Kashmir	Shrub	April-June
44	*Berberis pseudumbellata subsp. G.B.ica*	Berberidaceae	G.B.	Shrub	May-June
45	*Berberis royleana Ahrendt*	Berberidaceae	Pak & Kashmir	Shrub	May-June
46	*Berberis stewartiana Jafri*	Berberidaceae	Kashmir	Shrub	May-June
47	*Bongardia margalla R.R.Stewart*	Berberidaceae	Hazara, Margalla	Herb	June-July
48	*Bupleurum canaliculatum Diels*	Apiaceae	G.B.	Herb	Aug
49	*Bupleurum clarkeanum*	Apiaceae	Kashmir	Herb	July-Aug
50	*Bupleurum constancei Nasir*	Apiaceae	Swat	Herb	July-Aug
51	*Bupleurum jucundum Kurz*	Apiaceae	Kashmir	Herb	July-Aug
52	*Bupleurum kohistanicum Nasir*	Apiaceae	Swat	Herb	July-Aug
53	*Bupleurum nigrescens Nasir*	Apiaceae	Hazara	Herb	July-Aug
54	*Bupleurum stewartianum Nasir*	Apiaceae	Swat	Herb	July-Aug
55	*Bupleurum swatianum Nasir*	Apiaceae	Swat	Herb	July-Aug
56	*Buxus papillosa C.K.Schneid*	Buxaceae	Punjab, KP Balochistan,	Tree	Jan-May
57	*Calamagrostis decora Hook. F*	Poaceae	G.B. & Kashmir	Grass	April-July
58	*Calamintha hydaspidis (Falconer ex Benth.)*	Lamiaceae	Kashmir	Herb	June-Sep
59	*Campanula staintonii Rech.f. & Schiman-Czeika*	Campanulaceae	Chitral	Undershrub	April-may
60	*Campanula sulaimanii Nasir*	Campanulaceae	Sulaiman and Salt ranges	Herb	May-Aug
61	*Campanula tenuissima Dunn*	Campanulaceae	Jhelum, Kashmir	Herb	July-Aug
62	*Caragana ambigua Stocks*	Leguminosae	Balochistan	Shrub	April-Aug
63	*Caragana conferta Baker*	Leguminosae	Kashmir	Shrub	July
64	*Caragana ulicina Stocks*	Leguminosae	Balochistan	Shrub	April
65	*Caralluma tuberculata N.E.Br*	Apocynaceae	Punjab, KP, Balochistan	Herb	Jan-June
66	*Carex decaulescens subsp. alsia*	Cyperaceae	Chitral, G.B.	Herb	July
67	*Chesneya depressa (Oliv.)*	Leguminosae	G.B., Kashmir	Herb	May-July
68	*Clematis robertsiana Aitch. & Hemsl*	Ranunculaceae	Kurram Valley	Shrub	May-June
69	*Commiphora stocksiana (Engl.)*	Burseracea	Balochistan	Tree	April-July
70	*Consolida schlagintweitii (Huth) Munz*	Ranunculaceae	Kashmir	Herb	May-Aug
71	*Cortia depressa (D.Don)*	Apiaceae	G.B., Kashmir	Herb	June-Aug
72	*Cortia schmidii E. Nasir*	Apiaceae	Chitral	Herb	June-Aug
73	*Corydalis cashmeriana Royle*	Papaveraceae	Hazara, Kashmir	Herb	May-Aug
74	*Corydalis clarkei Prain*	Papaveraceae	Kashmir	Herb	June-Aug
75	*Corydalis clarkei Prain*	Papaveraceae	Kashmir	Herb	June-Aug

Table 1 Continued...

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
76	*Corydalis diphylla subsp. murreeana (Jafri) Lidén*	Papaveraceae	Murree, Kashmir	Herb	June-Aug
77	*Corydalis govaniana var. swatensis Jafri*	Papaveraceae	Swat	Herb	June-Aug
78	*Corydalis pakistanica Jafri*	Papaveraceae	Hazara, Kashmir	Herb	June-Aug
79	*Corydalis stewartii*	Papaveraceae	Kashmir	Herb	May-June
80	*Corydalis thyrsiflora Prain*	Papaveraceae	Kashmir	Herb	June-Aug
81	*Cousinia bipinnata Boiss*	Compositae	Balochistan	Herb	April-July
82	*Cousinia chitralensis Rech. f.*	Compositae	Chitral	Herb	June-Aug
83	*Cousinia chitralensis Rech.f.*	Compositae	Chitral	Herb	June-Aug
84	*Cousinia mattfeldii Bornm*	Compositae	Chitral	Herb	Sep-Oct
85	*Cousinia quettensis Rech.f.*	Compositae	Balochistan	Shrub	June-July
86	*Delphinium bicarpellatum Qureshi & Ch*	Ranunculaceae	Chitral	Herb	May-July
87	*Delphinium lacostei Danguy*	Ranunculaceae	Chitral	Herb	May-July
88	*Delphinium nordhagenii Wendelbo*	Ranunculaceae	Chitral	Herb	July-Aug
89	*Delphinium roylei Munz*	Ranunculaceae	Chitral, Kashmir	Herb	July-Aug
90	*Delphinium vestitum Boiss*	Ranunculaceae	Hazara, murree	Herb	July-Aug
91	*Digitaria stewartiana Bor*	Poaceae	Kashmir	Herb	Aug-Sep
92	*Dionysia lacei (Hemsl. & Watt) Clay*	Primulaceae	Balochistan	Herb	Mar-April
93	*Draba pakistanica Jafri*	Brassicaceae	Chitral	Herb	May-June
94	*Draba tenerrima O.E.Schulz*	Brassicaceae	Kashmir	Herb	June-July
95	*Duthiea oligostachya (Munro ex Aitch.)Poa*	Poaceae	Kurram valley	Herb	May
96	*Echinops prionolepis Bornm. & Mattf*	Compositae	G.B.	Herb	July-Aug
97	*Echinops sulaimanii Rech.f.*	Compositae	Koh e Sulaiman	Herb	May-June
98	*Elymus borianus (Melderis) Cope*	Poaceae	KP	Herb	July-Aug
99	*Elymus dentatus (Hook.f.)*	Poaceae	G.B., KP, Kashmir	Herb	July-Aug
100	*Elymus dentatus (Hook.f.) Tzvelev*	Poaceae	KP, G.B., Kashmir	Herb	July-Aug
101	*Elymus jacquemontii (Hook. f.)*	Poaceae	Kashmir	Herb	July-Aug
102	*Elymus kuramensis (Meld.)*	Poaceae	Kurram valley	Herb	July-Aug
103	*Elymus russellii (Melderis) Cope*	Poaceae	G.B.	Herb	July-Aug
104	*Elymus stewartii (Meld)*	Poaceae	Kashmir	Herb	July-Aug
105	*Elymus stewartii (Melderis) Cope*	Poaceae	Kashmir	Herb	July-Aug
106	*Epilobium aitchisonii P.H.Raven*	Onagraceae	Kurram valley	Herb	Aug-Nov
107	*Epilobium chitralense P.H.Raven*	Onagraceae	Chitral	Herb	July-Sep
108	*Epilobium glaciale P.H.Raven*	Onagraceae	G.B., Kashmir	Herb	July-Sep
109	*Epilobium rhynchospermum Hausskn*	Onagraceae	Punjab, Kashmir	Herb	July-Sep
110	*Epimedium elatum C.Morren & Decne*	Berberidaceae	Pak & Kashmir	Herb	June-Aug
111	*Erigeron cedretorum Rech.f*	Compositae	G.B.	Herb	June-July
112	*Euphorbia micractina Boiss*	Euphorbiaceae	Kashmir	Herb	July-Aug
113	*Euphorbia talaina Radcl*	Euphorbiaceae	Balochistan	Herb	May-Aug
114	*Euphorbia thyrsoidea Boiss*	Euphorbiaceae	Swat	Herb	July-Oct
115	*Euphrasia aristulata Pennell*	Orobanchaceae	Kashmir	Herb	July-Sep
116	*Euphrasia densiflora Pennell*	Orobanchaceae	Swat, Kashmir	Herb	Aug-Sep
117	*Euphrasia flabellata Pennell*	Orobanchaceae	G.B., Kashmir	Herb	July-Aug
118	*Euphrasia foliosa Pennell*	Orobanchaceae	G.B., Kashmir	Herb	June-July
119	*Euphrasia incisa Pennell*	Orobanchaceae	G.B., Kashmir	Herb	July-Aug
120	*Euphrasia Kashmiriana Pugsley*	Orobanchaceae	G.B., Kashmir	Herb	June-Aug
121	*Euphrasia multiflora Pennell*	Orobanchaceae	Swat, G.B.	Herb	Aug-Sep
122	*Euphrasia omeri Qaiser & Siddiqui*	Orobanchaceae	Chitral, Kashmir	Herb	July-Aug

Table 1 Continued...

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
123	*Euphrasia platyphylla Pennell*	Orobanchaceae	Naran, Kashmir	Herb	Aug
124	*Euphrasia qaiseri Siddiqui*	Orobanchaceae	Chitral, Kashmir	Herb	June-Aug
125	*Euphrasia remota Pennell*	Orobanchaceae	G.B., Kashmir	Herb	June-Aug
126	*Ferula stewartiana O.E.Schulz*	Apiaceae	Hassan abdal	Shrub	April-May
127	*Festuca debilis (Stapf)*	Poaceae	Kashmir	Grass	July-Aug
128	*Festuca hartmannii (Markgr.-Dann.)*	Poaceae	KP, Kashmir	Grass	July-Aug
129	*Festuca Kashmiriana Stapf*	Poaceae	Kashmir	Grass	July-Aug
130	*Festuca levingei Stapf*	Poaceae	Kashmir	Grass	July-Aug
131	*Gagea alii Levichev*	Liliaceae	Balochistan	Herb	March
132	*Gagea Balochistanica Levichev & Ali*	Liliaceae	Balochistan	Herb	Mar-April
133	*Gagea quettica Levichev & Ali*	Liliaceae	Balochistan	Herb	Feb-April
134	*Gagea rawalpindica Levichev & Ali*	Liliaceae	Hazara, Rawalpindi	Herb	March
135	*Gagea utriculosa Levichev*	Liliaceae	Punjab	Herb	March
136	*Galium Asperifolium Wall var. obovatum*	Rubiaceae	Hazara, Rawalpindi	Herb	July-Sep
137	*Galium ceratophylloides Hook.f*	Rubiaceae	Kahmir, murree	Herb	July-Sep
138	*Galium subfalcatum Nazim. & Ehrend*	Rubiaceae	Hazara	Herb	July-Aug
139	*Galium tetraphyllum Nazim. & Ehrend*	Rubiaceae	Hazara	Herb	July-Aug
140	*Gaultheria trichophylla Royle*	Ericaceae	Hazara, Kashmir	Shrub	May-July
141	*Gentiana kurroo Royle*	Gentianaceae	Hazara, Murree, Kashmir	Herb	Sep-Nov
142	*Gentianodes cachemirica (Decne.)*	Gentianaceae	Chitral, Kashmir	Herb	Sep-Nov
143	*Gentianodes lowndesii (Blatt.)*	Gentianaceae	Waziristan	Herb	Sep-Oct
144	*Geranium swatense Schönb*	Geraniaceae	Swat, G.B.	Herb	June-Aug
145	*Graellsia chitralensis O.E.Schulz*	Brassicaceae	Chitral	Herb	June-July
146	*Habenaria aitchisonii Rchb.f.*	Orchidaceae	Kurram valley	Herb	July-Aug
147	*Hackelia macrophylla I.M. Johnst.*	Boraginaceae	Kashmir	Herb	June-July
148	*Heliotropium Balochistanicum Kazmi*	Boraginaceae	Balochistan	Undershrub	May
149	*Heliotropium dasycarpum var. gymnostomum Kazmi*	Boraginaceae	Waziristan	Undershrub	April-May
150	*Heliotropium lamondiae Kazmi*	Boraginaceae	Balochistan	Undershrub	Mar-April
151	*Heliotropium ophioglossum C.B. Clarke*	Boraginaceae	Sindh	Herb	Dec-Jan
152	*Heliotropium remotiflorum Rech. f. & Riedl*	Boraginaceae	Makran	Herb	April-May
153	*Heliotropium ulophyllum Rech. f. & Riedl*	Boraginaceae	Loralai	Herb	May
154	*Hylotelephium pakistanicum*	Crassulaceae	G.B., Kashmir	Herb	Aug
155	*Impatiens edgeworthii Hook. f.*	Balsaminaceae	Hazara, Kashmir	Herb	July-Sep
156	*Impatiens meeboldii Hook. F*	Balsaminaceae	G.B., Kashmir	Herb	Mar-April
157	*Indigofera nephrocarpa Balf. f.*	Leguminosae	Makran	Herb	Mar-April
158	*Iris crocea Jacquem. ex R.C.Foster*	Iridaceae	Kashmir	Herb	June
159	*Iris Kashmiriana Baker*	Iridaceae	Kashmir	Herb	May
160	*Lagotis blatteri O.E.Schulz*	Plantaginaceae	Waziristan	Herb	March
161	*Launaea quettaënsis N.Kilian*	Compositae	Sindh, Balochistan	Herb	May-dec
162	*Lepechiniella microcarpa (Boiss.) Riedl*	Boraginaceae	Chitral, Kashmir	Herb	May
163	*Lespedeza elegans Cambess*	Leguminosae	KP, Kashmir	Shrub	Aug-Oct
164	*Lycium makranicum Schonebeck*	Solanaceae	Makran	Shrub	Sep-April
165	*Mattiastrum karakoricum Podlech & Sadat*	Boraginaceae	Hunza	Herb	July-Aug
166	*Megacarpaea polyandra Benth. ex Maden*	Brassicaceae	G.B., Kashmir	Herb	May-July
167	*Melanoseris decipiens var. pakistanica*	Asteraceae	G.B., Kashmir	Herb	July-Sep
168	*Melanoseris gilgitensisnsis (Bano, Roohi & Qaiser)*	Asteraceae	Haramosh, G.B.	Herb	Aug

Table 1 Continued...

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
169	*Melanoseris Kashmiriana (Mamgain & R.R. Rao)*	Asteraceae	Kashmir	Herb	Sep-Nov
170	*Melanoseris stewartii (Roohi & Qaiser)*	Asteraceae	Kashmir	Herb	June-July
171	*Moluccella otostegioides Prain*	Lamiaceae	Sulaiman range	Undershrub	July-Sep
172	*Impatiens flemingii Hook. f.*	Balsaminaceae	Hazara, Kashmir	Herb	July-Sep
173	*Muhlenbergia duthieana Hack*	Poaceae	Punjab, KP	Herb	Aug-Oct
174	*Nanorrhinum ramosissimum subsp. pakistanicum G.R.Sarwar*	Plantaginaceae	Muzaffarbad, Swat Abbottabad, Makran Mansehra, Larkana,	Herb	March-Oct
175	*Nepeta adenophyta Hedge*	Lamiaceae	G.B.	Herb	Aug
176	*Nepeta glechomifolia (Dunn) Hedge*	Lamiaceae	Chitral	Herb	April-Oct
177	*Nepeta griffithii Hedge*	Lamiaceae	Malakhand	Herb	April-Oct
178	*Nepeta schmidii Rech.f.*	Lamiaceae	Chitral	Herb	April-Oct
179	*Olgaea thomsonii (Hook.f.)*	Compositae	Kashmir, G.B.	Herb	June-Aug
180	*Onobrychis stewartii Baker*	Leguminosae	Rawalpindi, hazara	Herb	June-Sep
181	*Orobanche clarkei Hook. f.*	Orobanchaceae	G.B., Kashmir	Herb	June-Aug
182	*Oxytropis birirensis Ali*	Leguminosae	KP	Herb	May
183	*Oxytropis chitralensis Ali*	Leguminosae	Chitral	Herb	June-July
184	*Oxytropis gloriosa Ali*	Leguminosae	Chitral	Herb	June-July
185	*Oxytropis sikaramensis (*Širj. *& Rech.f.)*	Fabaceae	Kurram valley	Herb	June-July
186	*Oxytropis staintoniana Ali*	Leguminosae	Chitral	Herb	May
187	*Paracaryum intermedium var. calathicarpum*	Boraginaceae	Balochistan	Herb	April
188	*Pedicularis elephantoides Benth.*	Orobanchaceae	Hazara, Kashmir	Herb	June-Sep
189	*Pedicularis Kashmiriana Pennell*	Orobanchaceae	Hazara, Kurram, G.B	Herb	July-Sep
190	*Pedicularis multiflora Pennell*	Orobanchaceae	Kashmir	Herb	July-Sep
191	*Pedicularis murreeana R.R. Mill*	Orobanchaceae	Rawalpindi, Murree	Herb	July-Oct
192	*Pedicularis numeniicephala T.Yamaz*	Orobanchaceae	Kashmir	Herb	June-Aug
193	*Pedicularis staintonii R.R.Mill*	Orobanchaceae	Chitral, G.B.	Herb	June-Aug
194	*Pimpinella hazariensis H. Wolff*	Apiaceae	Hazara	Herb	June-Aug
195	*Pimpinella stewartii Nasir*	Apiaceae	Chitral, Hazara,	Herb	June-Aug
196	*Poa stewartiana Bor*	Poaceae	Hazara, Kashmir	Grass	July
197	*Polygonum cashmiriense H.Gross*	Polygonaceae	Kashmir	Herb	June-Aug
198	*Polygonum cognatum subsp. Chitralicum*	Polygonaceae	Chitral	Herb	June-Aug
199	*Primula clarkei G.Watt*	Primulaceae	Kashmir	Herb	May-June
200	*Primula duthieana Balf. f. & W.W. Sm.*	Primulaceae	Hazara, Kashmir	Herb	July-Aug
201	*Primula obtusifolia Royle*	Primulaceae	Kashmir	Herb	June-July
202	*Psammogeton stocksii (Boiss.) Nasir*	Apiaceae	Balochistan	Herb	Mar-April
203	*Pseudomertensia chitralensis Riedl*	Boraginaceae	Chitral	Herb	May
204	*Pseudomertensia drummondii Kazmi*	Boraginaceae	G.B.	Herb	June-July
205	*Pseudomertensia efornicata (Rech. f. & Riedl)*	Boraginaceae	Chitral	Herb	June-July
206	*Pseudomertensia efornicata (Rech. f. & Riedl) Riedl*	Boraginaceae	Chitral	Herb	June-July
207	*Pseudomertensia elongata (Decne.) Riedl*	Boraginaceae	Hazara, Kashmir	Herb	June-Aug
208	*Pseudomertensia moltkioides (Royle ex Benth.)*	Boraginaceae	Kashmir	Herb	July-Aug
209	*Pseudomertensia nemorosa (A. DC.) Stewart & Kazmi*	Boraginaceae	Kashmir	Herb	April-May
210	*Pseudomertensia sericophylla (Riedl) Y.J. Nasir*	Boraginaceae	Kurram valley, Hazara	Herb	Aug
211	*Pseudomertensia trollii Stewart & Kazmi var. trollii*	Boraginaceae	Kashmir	Herb	May-June
212	*PseudPseudomertensia trollii var. harrissii Kazmiomertensia trollii Stewart & Kazmi var. trollii*	Boraginaceae	Chitral	Herb	June-July

Table 1 Continued...

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
213	*Psudomertensia moltikioides var. primuloides*	Boraginaceae	Kashmir	Herb	July-Aug
214	*Psudomertensia moltikioides var. tanneri*	Boraginaceae	G.B.	Herb	May
215	*Psychrogeton chitralicus Grierson*	Asteraceae	Chitral	Herb	June-Aug
216	*Puccinellia minuta Bor*	Poaceae	Chitral	Herb	May-June
217	*Puccinellia stapfiana R.R.Stewart*	Poaceae	Kashmir	Herb	May-June
218	*Puccinellia thomsonii (Stapf) R.R.Stewart*	Poaceae	Kashmir	Herb	May-June
219	*Pulicaria balochistanica Qaiser & Abid*	Asteraceae	Quetta	Herb	Aug-Sep
220	*Pulsatilla wallichiana (Royle)*	Ranunculaceae	G.B., Kashmir	Herb	May-June
221	*Ranunculus karakoramicola Tamura*	Ranunculaceae	Baltistan	Herb	June-July
222	*Ranunculus membranaceus Royl*	Ranunculaceae	Kashmir	Herb	June-July
223	*Ranunculus munroanus J.R.Drumm. ex Dunn*	Ranunculaceae	Kashmir	Herb	April-June
224	*Ranunculus palmatifidus Riedl*	Ranunculaceae	Kashmir	Herb	June-July
225	*Ranunculus stewartii Riedl*	Ranunculaceae	Baltistan	Herb	May-June
226	*Rhodiola saxifragoides (Fröd.)*	Crassulaceae	GB, Kashmir	Herb	April-Sep
227	*Rhododendron afghanicum Aitch. & Hemsl*	Ericaceae	Kurram valley	Shrub	May-June
228	*Rostraria clarkeana (Domin) Holub*	Poaceae	Kashmir	Grass	June-July
229	*Rubia infundibularis Hemsl. & Lace*	Rubiaceae	Balochistan	Undershrub	May-Sep
230	*Ruellia sindica Ghafoor & Heine*	Acanthaceae	Sindh	Herb	Aug-Oct
231	*Rumex crispellus Rech. F*	Polygonaceae	Chitral, Hazara, Kurram	Herb	
232	*Rydingia limbata (Benth.)*	Lamiaceae	Jhelum, Rawalpindi, Kashmir	Shrub	April-May
233	*Saponaria subrosularis Rech. F*	Caryophyllaceae	Quetta	Herb	May
234	*Saxifraga afghanica Aitch. & Hemsl*	Saxifragaceae	Kurram valley	Herb	May-July
235	*Scaligeria stewartiana (Nasir) Nasir*	Apiaceae	Rawalpindi, Swat, Margallah	Herb	April-Oct
236	*Schoenoplectus rechingeri Kukkonen*	Cyperaceae	swat	Herb	June
237	*Scorzonera gageoides Boiss*	Compositae	Balochistan	Herb	April-July
238	*Scorzonera hondae Kitam*	Compositae	Hunza	Herb	June-Aug
239	*Scrophularia edelbergii subsp. pseudodeserti Grau*	Scrophulariaceae	Kurram valley	Shrub	July-Oct
240	*Scrophularia jafrii Khatoon & Qaiser*	Scrophulariaceae	G.B.	Herb	May-Sep
241	*Scrophularia nudata Pennell*	Scrophulariaceae	G.B.	Herb	June-Aug
242	*Scrophularia omeri Khatoon & Qaiser*	Scrophulariaceae	G.B.	Herb	Mar-June
243	*Scrophularia rodinii Hamidullah*	Scrophulariaceae	Landi kotil,	Herb	Mar-June
244	*Scrophularia scabiosifolia subsp. stewartii (Pennell) Qaiser & Khatoon*	Scrophulariaceae	Baltistan	Herb	May-Aug
245	*Scutellaria chamaedrifolia Hedge & A.J.Paton*	Lamiaceae	Chitral	Herb	April-June
246	*Scutellaria swatensis Murata*	Lamiaceae	Chitral	Herb	June-Oct
247	*Seriphidium quettense (Podlech) Y.R.Ling*	Compositae	Quetta	Shrub	May-Nov
248	*Sida spinosa L*	Malvaceae	Jhelum, Thatta, Pind dadankhan	Undershrub	May-June
249	*Silene kunawarensis Benth*	Caryophyllaceae	Kashmir, G.B.	Herb	July-Sep
250	*Silene longiSepala Nasir*	Caryophyllaceae	Chitral	Herb	May
251	*Silene staintonii Ghaz*	Caryophyllaceae	Chitral	Herb	May
252	*Sorbaria tomentosa (Lindl.) Rehder*	Rosaceae	Chitral	Shrub	July-Nov
253	*Sorbus cashmiriana Hedl*	Rosaceae	Kashmir	Herb	May-June
254	*Sorbus G.B.ana McAll*	Rosaceae	G.B.	Tree	Oct
255	*Sorbus rosea McAll*	Rosaceae	G.B.	Tree	Oct
256	*Spiraea brahuica Boiss.*	Rosaceae	Loralai, Quetta, Ziarat	Shrub	July
257	*Spiroseris phyllocephala Rech.f.*	Compositae	Kohat	Herb	May-June

Table 1 Continued...

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
258	*Stipa chitralensis Bor*	Poaceae	Chitral	Herb	May
259	*Syringa emodi Wall. ex Royle*	Oleaceae	Hazar, Changla gali, Ghora gali,	Shrub	May-July
260	*Syzygium cumini (L.) Skeels*	Myrtaceae	Rawalpindi, sub Himalayan	Tree	March-may
261	*Tamarix pakistanica Qaiser*	Tamaricaceae	Thatta, Hyderabad	Shrub	Jan-Oct
262	*Tamarix salina Dyer*	Tamaricaceae	Sindh, Punjab	Shrub	January
263	*Tanacetum baltistanicum Podlech*	Asteraceae	G.B., Hunza	Shrub	Aug-Sep
264	*Tanacetum chitralense (Podlech) K.Bremer & Humphries*	Asteraceae	Chitral	Shrub	July-Aug
265	*Tanacetum chitralense (Podlech) K.Bremer & Humphries*	Asteraceae	Chitral	Herb	July-Aug
266	*Tanacetum pakistanicum Podlech*	Asteraceae	Swat	Herb	July-Aug
267	*Tanacetum stoliczkae (C.B.Clarke) R.Khan*	Asteraceae	Kashmir	Herb	July-Aug
268	*Taraxacum baltistanicum Soest*	Asteraceae	Baltistan	Herb	May-July
269	*Taraxacum canum Soest*	Asteraceae	G.B., Hazara	Herb	April-June
270	*Taraxacum gilgitensis Abedin*	Asteraceae	G.B, Hunza	Herb	June
271	*Taraxacum gulmargense Soest*	Asteraceae	Kashmir	Herb	June-Aug
272	*Taraxacum ladakense Soest*	Asteraceae	Chitral, Kashmir	Herb	July-Sep
273	*Taraxacum longirostre Schischk.*	Asteraceae	Chitral	Herb	July-Aug
274	*Taraxacum mansehracum Abedin*	Asteraceae	Mansehra	Herb	May-June
275	*Taraxacum melleum Soest*	Asteraceae	Baltistan	Herb	July
276	*Taraxacum nagaricum Soest*	Asteraceae	G.B.	Herb	July-Sep
277	*Taraxacum nasiri Soest*	Asteraceae	Chitral	Herb	July-Aug
278	*Taraxacum nigrum Soest*	Asteraceae	G.B.	Herb	July-Aug
279	*Taraxacum obtusum (Soest) R.Doll*	Asteraceae	Chitral	Herb	June-July
280	*Taraxacum pakistanicum Soest*	Asteraceae	Kurram Valley	Herb	April-May
281	*Taraxacum pseudotenebristylum Soest*	Asteraceae	Chitral	Herb	June July
282	*Taraxacum pubens Soest*	Asteraceae	G.B.	Herb	July-Aug
283	*Taraxacum qaiseri Abedin*	Asteraceae	G.B.	Herb	July-Aug
284	*Taraxacum quettacum Abedin*	Asteraceae	Quetta	Herb	May-June
285	*Taraxacum rawalpindicum Abedin*	Asteraceae	Rawalpindi	Herb	May-June
286	*Taraxacum stewartii Soest*	Asteraceae	Kashmir	Herb	July-Aug
287	*Taraxacum tricolor Soest*	Asteraceae	Chitral	Herb	June-Aug
288	*Taraxacum tricolor Soest*	Asteraceae	Kashmir	Herb	Aug
289	*Taraxacum wendelboanum Soest*	Asteraceae	Chitral	Herb	June-Aug
290	*Taraxacum xanthophyllum G.E.Haglund*	Asteraceae	G.B.	Herb	July
291	*Tephrosia rechingeri Ali*	Fabaceae	Quetta	Herb	May
292	*Tephrosia shamimii Ali*	Fabaceae	Quetta	Herb	Sep
293	*Teucrium stocksianum subsp. patulum (Hedge & Lamond) Rech.f.*	Lamiaceae	Quetta	Herb	May-Aug
294	*Teucrium stocksianum var. patulum Hedge & Lamond*	Lamiaceae	Quetta	Herb	May-Aug
295	*Thalictrum secundum Edgew*	Ranunculaceae	Hazara	Herb	July-Aug
296	*Thalictrum secundum var. hazaricum*	Ranunculaceae	Hazara, Dunga Gali	Herb	July-Aug
297	*Thesium himalense Royle*	Santalaceae	Hazara, Kashmir	Herb	April-June
298	*Tricholepis infundibuliformis Dittrich*	Asteraceae	Basham, Patan	Undershrub	July-Aug
299	*Trigonella podperae (Sirj.) Vassilcz*	Leguminosae	Kashmir	Herb	July-Aug
300	*Vincetoxicum arnottianum (Wight) Wight*	Apocynaceae	Hazara, Kashmir	Herb	April-July
301	*Vincetoxicum arnottianum (Wight) Wight*	Rubiaceae	Hazara, Rawalpindi, Kashmir	Tree	May-June

S. No.	Species	Family	Distribution	Life form / Status	Flowering period
302	*Wendlandia puberula DC.*	Rubiaceae	Hazara, Rawalpindi, Kashmir	Tree	May-June
303	*Xylanthemum macropodum (Hemsl. & Lace) K.Bremer & Humphries*	Compositae	Balochistan	Shrub	May-June
304	*Pinus gerardiana Wall. ex D. Don*	Pinaceae	Chitral, Kalam, Balochistan	Tree	May-June
305	*Sorbus G.B.ana McAll.*	Rosaceae	G.B.	Tree	Oct
306	*Sorbus rosea McAll.*	Rosaceae	G.B.	Tree	Oct

Source: Flora of China Editorial Committee. (n.d.). eFloras.org. Retrieved March 20, 2021, from http://www.efloras.org/; The Plant List, "The Plant List - A Working List of All Plant Species," Accessed: May. 29, 2021. [Online]. Available: http://www.theplantlist.com/.; Plants of the World Online, "Plants of the World Online - Kew Science," Accessed: Jun. 12, 2021. [Online]. Available: http://www.powo.science.kew.org/.)

3. RESULTS

During present investigation, a total of 306 plant species categorized into 126 genera and 50 families were found endemic to Pakistan **(Fig. 2)**. The most dominant family is Astereaceae (n= 38 species), followed by Boraginaceae, Poaceae and Ranunculaceae (n = 22, 22 and 22 species respectively). The family with least number of species is Lamiaceae (n = 11 species) (**Fig. 3**).

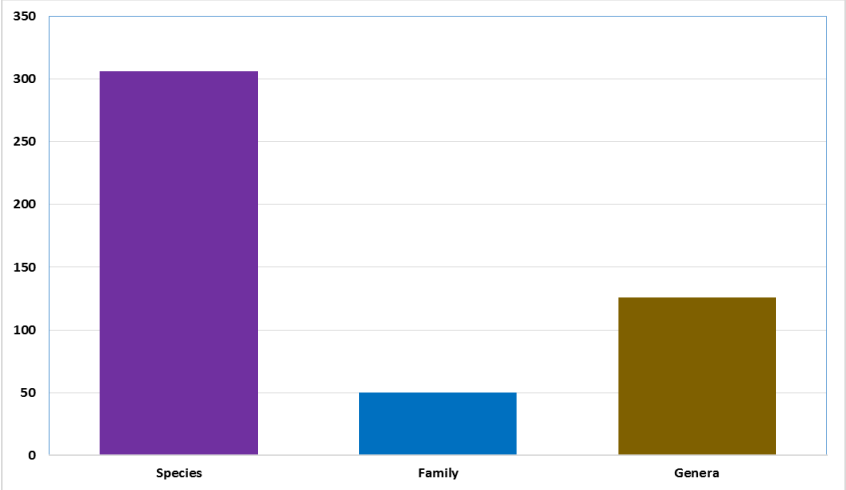

Fig. 2. Total number of endemic plant species of Pakistan and their distribution in genera and families.

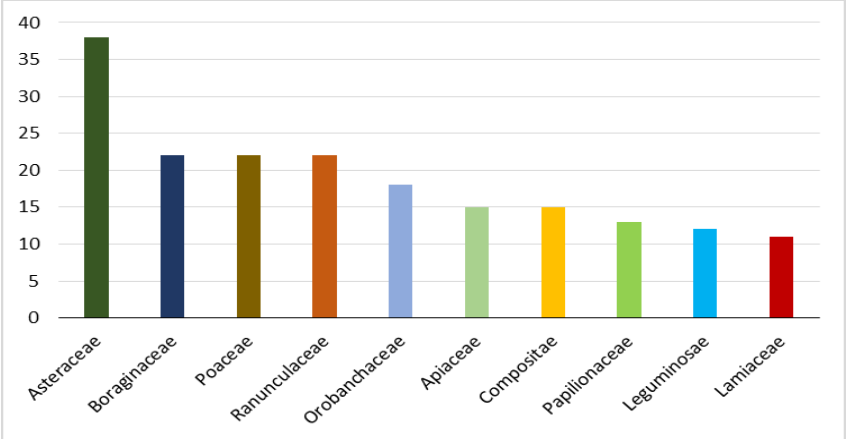

Fig. 3. Dominant families presenting the number of endemic plant species in Pakistan.

Data analysis of life-form indicates that herbs constitutes 80 % (n = 243 species), followed by shrubs 11 % (n = 32) and tree 3 % (n = 10). While, undershrub constitutes 4 % (n = 13) and grasses 2 % (n = 6) **(Fig. 4)**. The study reveals that, the most dominant genus is *Taraxacum* (n = 23 species), followed by *Astragalus* (n = 13 species), *Pseudomertensia* (n =12 species), and *Euphrasia* (n = 11 species). The genera *Berberis, Bupleurum, Corydalis* and *Elymus* represents (n =8 species) each **(Fig. 5)**. While seventy eight genera represents only single species and fourteen genera represents two species each.

The study revealed that most endemic plant species were from Khyber Pakhtunkhwa (KP) Province (n = 148 species, 37 %), followed by Azad Jammu and Kashmir (AJK) (n = 110 species, 28 %). The GB represents (n=59 species, 15 %), Balochistan (n=42 species, 11 %), and Punjab (n=26 species, 7 %). The least number of endemic species were recorded from Sindh (n=10, 3 %)

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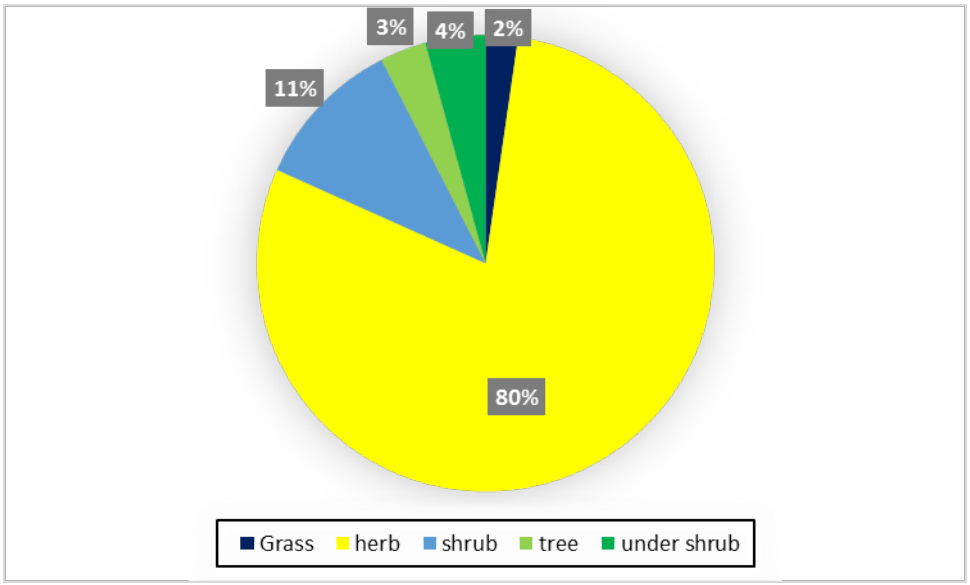

Fig. 4. Life forms / habitat status of endemic plant species of Pakistan

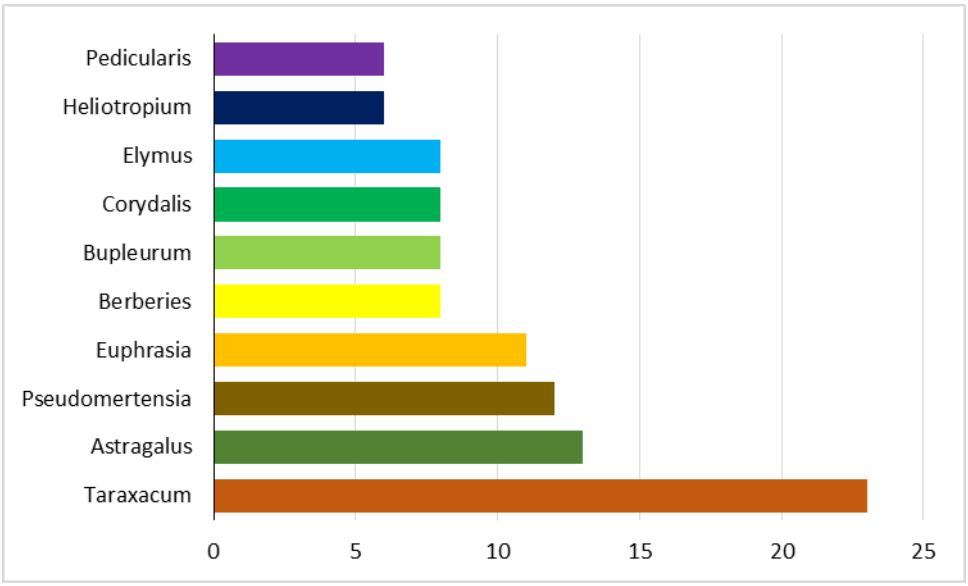

Fig. 5. Dominant genera showing number of endemic species in the study area.

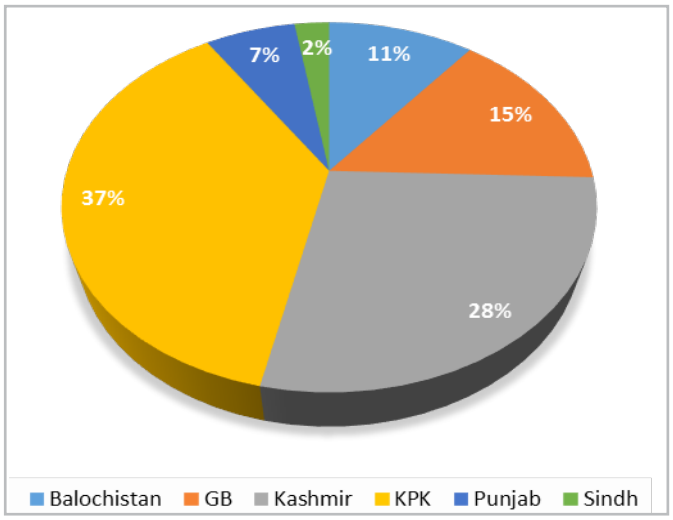

Fig. 6. Endemic richness in different areas of Pakistan.

(Fig. 6).

4. DISCUSSION

The catalogue of endemic plant species and datasets is not available to capture the comprehensive information regarding the endemic plant species in Pakistan. Previously some studies [13-17, 29] reported the endemics ranges. These studies represent only 5 % of Pakistan's endemic flora. In this scenario, this study conducted to focus on the documentation of endemic flora of Pakistan. This study of plant species endemism will benefit groundwork for future research into the protection of endemic, rare, indigenous and natural forest vegetation in Pakistan. The study found that northern Pakistan is rich in endemism, and majority of endemic plant species are distributing in mountainous areas of Chitral, Gilgit and Kashmir. The results also revealed that most of the endemic plant species are located above 1000 m, which indicated that altitude is one of the important factor in endemism **(Fig. 7)**.

Three hundred and six endemic species were found in the research region, the major genera being *Taraxacum, Astragalus,* and *Pseudomertensia*, with the largest families being *Asteraceae* and *Boraginaceae*. Previous study conducted by Majid *et al* [10] also reported Boraginaceae as largest family in Himalayan region in terms of endemism. The study area's distribution of more than 300 endemic species indicates the area's richness and value as a source of biodiversity. The complex genus *Pseudomertensia* has roughly 2000 species worldwide [30]. Herbs substantially outnumbered shrubs and trees among endemic taxa. Richness of herbaceous flora over trees and shrubs demonstrates that herbaceous flora has undergone more speciation than woody species [31, 32]. Our findings concur with several other findings [33-36]. Ten trees are said to be endemic when looking at endemism at the national level.

Berberis parkeriana, Otostegia limbata, Aegopodium burttii, Caltha alba var. alba, Scaligeria indica, Clinopodium hydaspidis, Pimpinella stewatii, and *Alchemilla cashmeriana* were the species with the greatest geographic distribution. Many endemics can have enormous populations inside their distributional zones, but they are unable to expand outside of such zones [37]. The *Otostegia limbata* is widely found throughout Pakistan and even at the borders with Afghanistan and India, however it has never been described from these two nearby nations [38, 39]. The fact that the environment and rock strata are suitable and exclusive to this country may be one factor.

5. CONCLUSION

The current study sheds light on Pakistan's endemism situation. An essential component of conservation strategy is accurate cataloguing of endemic plant species. In comparison to neighboring nations, Pakistan has a notably high number of endemic plants. However, Pakistan has a heavy burden for

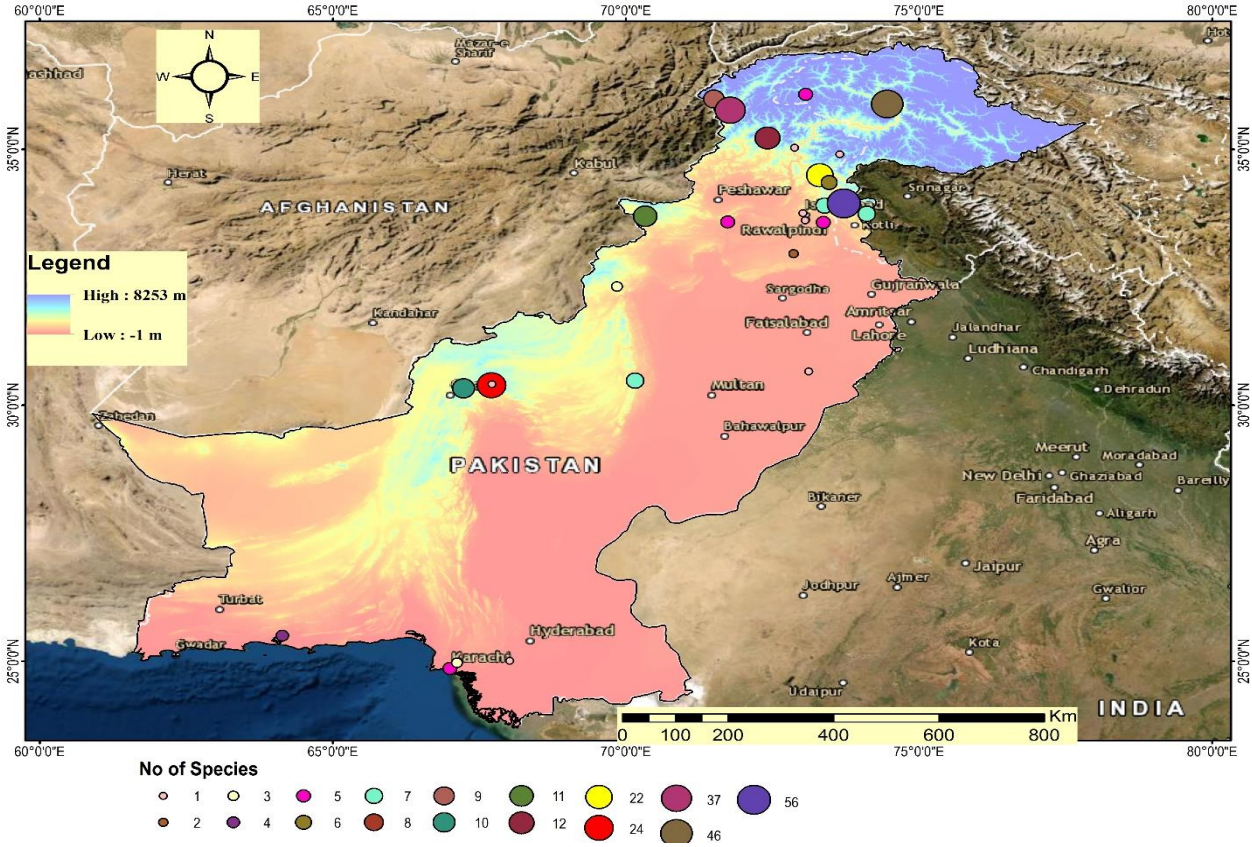

Fig. 7. Map illustrating the occurrence of three hundred and six endemic plant species in Pakistan. The size and colour of bubble represents the number of species at a particular area.

their preservation since these unique taxa support regional biodiversity. Unfortunately, there is still a huge gap in our understanding and evaluation of the taxa's conservation status. Furthermore, the current study can provide as a springboard for the systematic answer to this issue. Our findings show that mountainous regions in Pakistan should be given priority for conservation because they are home to the majority of Pakistan's endemic plant species. To help guide conservation efforts and the creation of protected areas. The current study sheds light on Pakistan's endemism situation. Further research that takes into consideration population levels and threats is also required.

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7. CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest concerning research, authorship, and/or publication of this article.

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