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A review on *Berberis* species reported from Gilgit-Baltistan and Central Karakoram National Park, Pakistan.

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Abstract

Genus *Berberis* is medicinally, ecologically, commercially and ethnobotanically important yellow woody plants. There are two subspecies of *Berberis pseudumbellata* Parker found in Gilgit-Baltistan, however, since 1935 more than 33 researchers have reported fourteen (14) *Berberis* species and subspecies. Species found exhibit close morphological similarity. This review is compiled for the first time and will help researchers to overcome ongoing confusion during field based discrimination. *Berberis pseudumbellata* Parker subsp. *gilgitica* is endemic to Gilgit-Baltistan and has become critically endangered.

Keywords: *Berberis*, Review, Karakorum, Himalaya, Hindukush, distribution, Gilgit-Baltistan.

1. Introduction

The family Berberidaceae was first established by A. L. de Jussieu (1789) as 'Berberides' (Tiwari *et al.* 2012). There are about *ca* 17 genera in family comprising upon 650 species worldwide. *Berberis* is the most established genus and contains more than *ca* 450 species [2, 29, 37]. It is one of the most primitive angiosperm [5] and has remained as a familiar therapeutic agent among various healthcare systems [13, 28, 30].

Almost all the members of the genus are restricted to northern hemisphere exhibiting a global distribution with a higher concentration in Asian continent having center in the Himalayan region [6, 29]. Moreover, *Berberis* extends into South America where it has a secondary center of diversity [29]. *B. vulgaris* L is native to Europe. Similarly, *B. koreana* Palib has distribution in Korea [13] and *B. holstii* Engl is endemic to the mountains of Eastern and Southern Africa (Maliwichi-Nyirenda *et al.* 2011).

It is a genus of spiny, deciduous, evergreen shrubs or small trees with characteristic yellow wood and flowers (Anonymous 1988). Apart from its medicinal uses, some of the species are also used as a source of natural dye (Tutak & Ebru Korkmaz 2012; Haji 2010). Fruits of *Berberis* (barberry) are commonly used in Persian and Georgian cuisines (Siow *et al.* 2011).

Regions and countries include Pakistan, China, India, Central and Western Asia, Japan, South-East Asia, Europe, East Africa, North and South America [7, 34]. Therefore, it is assumed that it has most probably originated in northern hemisphere during the Cenozoic period. However, a complete biogeographical study of all genera of the tribe is still lacking [10, 35]. Few scattered *Berberis* species have been reported from Africa [2]. According to Li (2010) [31] the genus originated in eastern Asia and has migrated from eastern Asia to North America in the Oligocene period (33.9 million to 23 million years). In view of Chapman (1936) [8], carpellary anatomic features suggest that Berberidaceae and Ranunculaceae arose by parallel evolution from a Proranalian complex.

Due to environmental and hybridization effects, *Berberis* exhibit extremely high morpho-pathological and phytochemical variation, making taxonomic identification difficult (Khan *et al.* 2014; Rao *et al.* 1998a; Chapman 1936; Ahrendt 1961) [2, 8]. Overlapping characters, especially in the leaves, stem, and flower and berry size make field identification often challenging. Leaf texture and serrations vary from season to season and with the age of the plant in some of the species (Lucas *et al.* 2012; Tiwari & Adhikari 2011; Rao *et al.* 1998; Chapman 1936; Jafri 1975) [8, 14, 32].

Present research and review presented for the first time focuses on total reports on *Berberis* from Gilgit-Baltistan and Central Karakoram National Park. The Study will help researchers to

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overcome field based identification, planners and conservationists to use as a reference for future researches and projects.

2. Material and Methods

The study is based on the published data both online and print. Data and report coverage ranges from 1935 to 2014. Geography in focus is Gilgit-Baltistan and Central Karakoram National Park (CKNP), which is the largest protected area in Pakistan and holds the biggest glacial mass outside poles.

2.1 Parameters under study

During the study, reports available are organized into their chronological sequence, including the author/s and geography and location of its existence and report. Moreover, frequency of reports of any specific species has also been recorded (Table 1). Area (maximum stretched) of distribution has also been calculated (Table 3).

2.2 Area distribution calculation

Calculation of overall distribution area has been calculated using Google Earth, Google Earth Pro and GE-Path (v. 1.4.6).

3. Results and discussion

3.1 Distribution of Berberis in Pakistan

So far, 29 different *Berberis* species (20 species, 6 subspecies, 2 varieties and 1 forma) have been reported from Pakistan. These species are mostly distributed in the Northern mountainous ranges (Khan *et al.* 2014a; eFlora 2014; Jaffri 1975) [9, 14]. Table 1 gives a detailed account of species, subspecies, varieties and forma from Gilgit-Baltistan (GB) and Central Karakoram National Park (CKNP).

Stewart and Stewart (1935) were the first to report *Berberis* from Gilgit-Baltistan (Khan *et al.* 2014a). According to available literature, 33 researchers have reported 14 *Berberis* species (33 times) from Gilgit-Baltistan and CKNP (Figure).



Fig 1: Light green areas show the locations of *Berberis* reports since 1935 from Gilgit-Baltistan (formerly called Northern Areas of Pakistan). Map created using Google Earth and Paint features in MS office 2010 by the first author.

3.2 Distribution of Berberis in Gilgit-Baltistan

Berberis species have been reported from various parts of Gilgit-Baltistan and CKNP (Table 1 and 2). There are *Berberis pseudumbellata* Parker is found in different parts of Gilgit-Baltistan including Hunza, Nagar, Gilgit, Ghizir, Naltar,

Bagrot, Haramosh, Satpara, Burzil, Thale La, Astar-Gurikot, Hushe, Skardu, Karamber, Darkut, Bulashbar valley, Gilgit to Hunza, Nomal, Kargah, Skoro La-Baltistan, KNP and Shimshal, Diamer, Kuwardu, Arandu, Hoper, Ghanche, Rakaposhi, CKNP (Figure and Table 2).

Table 1: Summary of *Berberis* species reported from Gilgit-Baltistan and Central Karakoram National Park. Accepted names of species, subspecies, varieties and forma have been adopted from the Flora of Pakistan.

S#	Accepted Botanical Name (Species, subspecies variety)	Report Frequency	
		Gilgit-Baltistan	CKNP
1	<i>Berberis brandisiana</i>	6	5
2	<i>Berberis calliobotrys</i>	1	1
3	<i>Berberis kunawurensis</i>	1	1
4	<i>Berberis lycium</i>	6	4
5	<i>Berberis orthobotrys</i>	1	1
6	<i>Berberis orthobotrys</i> subsp. <i>capitata</i>	6	5
7	<i>Berberis orthobotrys</i> subsp. <i>orthobotrys</i>	7	5
8	<i>Berberis parkeriana</i>	1	1
9	<i>Berberis pseudumbellata</i>	1	1
10	<i>Berberis pseudumbellata</i> subsp. <i>gilgitica</i>	4	3
11	<i>Berberis pseudumbellata</i> subsp. <i>pseudumbellata</i>	5	5
12	<i>Berberis stewartiana</i>	3	-
13	<i>Berberis ulicina</i>	1	1
14	<i>Berberis vulgaris</i>	1	1

Table 2: Chronological ordered summary of *Berberis* reports from Gilgit-Baltistan and CKNP.

Year	Researcher/Author	Reported from (location)	<i>Berberis</i> Species												
			L	Br	OOr	OrC	PP	PGI	Ku	Pr	st	ul	vul.		
1935	Stewart	Gilgit-Baltistan					✓								
1939	Stewart, RR. & ID.	Gilgit Rd. 2800 m											✓		
1954	Stewart, RR.	Naltar 3300 m			✓										
1939	Stewart, RR. & ID.	Astor, Gurikot, Gilgit 2700 m			✓										
1963	Siddiqui, MA.	Baltistan-Sadpara lake			✓										
1955	Nisar, E & Webster GL	Hushe 4000 m, Astor; skardu 2600 m			✓	✓									
1936	Koelz, W.	Baltistan-Sodpur 4000 m		✓											
1956	Ali, Shoukat	Karamber, Darkut			✓								✓		
1940	Stewart, RR.	Skardu- satpara 3800 m, Burzil; Thale La		✓	✓			✓					✓	✓	
1946	Stewart, RR.	Astor-Gurikot 2800 m		✓	✓										
1974	Ghafoor, A. & Butt, ZL.	Skardu-Satpara;				✓			✓						
1974	Ghafoor, A.	Naltar 1000 ft							✓						
2000	Kashif M. Sheikh	Naltar Valley						✓				✓			
2003	Shinwari and Gilani	Bulashbar valley, Astore	✓												
2006	Qureshi <i>et al.</i>	Gilgit to Hunza, Astore, Gilgit, Nomal, Naltar, Kargah	✓								✓				
2007	Khan and Khatoon	Bagrot, Haramosh		✓		✓	✓								
2009	Alam and Ali	Naltar, Skoro La-Baltistan							✓						
2009	Sher wali Khan	Bagrot, Haramosh		✓		✓	✓	✓							
2011	Khan <i>et al.</i>	KNP and Shimshal	✓												
2013	Alamgeer <i>et al.</i>	Gilgit				✓									
2013	Abbas <i>et al.</i>	Naltar valley		✓		✓	✓								
2009	Ahmed A., Alamgir and Shrif, T. 2009;	Gilgit, Baltistan, Ghizir, Diamer, Astor, swat, Kashmir	✓												
2014	Bano <i>et al.</i>	Skardu													✓
2013	Awan., Jamal, Z., Khan, A.	Northern Areas	✓												
2013	Hussain <i>et al.</i> 2013	Kuwardu, Thally, Arandu, Hoper, Bagrote	✓												
2013	Khan <i>et al.</i> 2013	Chitral (Hindukush Mountain Ranges)						✓							
2013	Abbas <i>et al.</i> 2013	Naltar valley B.pp.						✓							
2011	Hussain, I., Bano, A., Ullah, F.	Ghanche and Skardu	✓												
2014	Khan <i>et al.</i> 2014	Gilgit-Baltistan (CKNP, Naltar)						✓	✓						
2014	Khan <i>et al.</i> 2014a	Rakaposhi, Gilgit, Bagrot, Naltar						✓	✓						
2014	Khan <i>et al.</i> 2014b	Rakaposhi, Gilgit, Hunza, Bagrot, Naltar						✓	✓						
2014	Khan <i>et al.</i> 2014b	Rakaposhi, Gilgit, Hunza, Bagrot, Naltar						✓	✓						
2014	Awan <i>et al.</i> 2014	CKNP (Gilgit-Baltistan)						✓							

Key: L (*B. lyceum*), Br (*B. brandisiana*), Or (*B. orthobotrys*), P (*B. pseudumbellata*), PP (*B. pseudumbellata pseudumbellata*), PGI (*B. pseudumbellata gilgitica*), Ku (*B. kunwarensis*), Pr (*B. parkeriana*), KNP (Khunjerab National Park), OOr (*B. orthobotrys orthobotrys*), OrC (*B. orthobotrys capitata*), Ca (*B. calliobotrys*), st (*B. stewartiana*), ul (*B. ulicina*), vul (*B. vulgaris*)

3.3 Area distribution calculation

District-wise area and perimeter calculations made show that total *Berberis* reported area with its maximum stretched is 3740 km² with a perimeter of 3580 km across Gilgit-Baltistan (Table 3). Area and perimeter calculated does not reflect actual Area of Occupancy (AOO) nor Extent of Occurrence (EOO) but a maximum theoretical stretch.

Table 3: District wise area calculation representing maximum stretch of *Berberis* reported. It reflects neither AOO nor EOO

S#	District	Area (km ²)	Perimeter (km)
1	Ghizir	1044.03	809.11
2	Astor	127.77	154.51
3	Diamer	585.99	609.2
4	Ghanche	399.38	454.29
5	Gilgit	376.45	380.23
6	Hunza/Nagar	566.05	586.98
7	Skardu	644.17	589.03
Total		3743.84	3583.35

4. Discussion

Since 1935 more than 33 researchers have reported fourteen (14) *Berberis* species and subspecies from Gilgit-Baltistan and CKNP. Species found exhibit close morphological similarity. This review is compiled for the first time and will help researchers to overcome ongoing confusion during field based discrimination. *Berberis pseudumbellata* Parker subsp. *gilgitica* is endemic to Gilgit-Baltistan and has become critically endangered.

Morphological difference level recorded across these species do not support an idea of 14 species or subspecies. However, this confusion may be due to several reasons; 1) overlapping characters which is an inherent feature of *Berberis* species under the influence of environmental conditions and hybridization, 2) Lack of sound taxonomic investigation, 3) quick field visits, which do not allow enough time to follow identification keys and 4) weak relevance of researchers to taxonomy. Mostly these confusions are with *B. brandisiana* Ahrendt, *B. jaeschkeana* Schneid., *B. orthobotrys* Bien. ex Aitch. and *B. stewartiana* Jafri and *B. pseudumbellata* Parker and *B. umbellata* Wall. ex G. Don (eFlora 2014) [9].

Present study contributes towards removing these confusions regarding *Berberis* species found in Gilgit-Baltistan and a comprehensive reference for future studies and researches. Moreover, we do not claim any to pass any final decision because of inherent overlapping features; it is therefore, genus specific detailed investigations are important. Protein and DNA characterization besides Phytochemistry would be some more reliable techniques and tools for precise discrimination across species, subspecies, varieties and forma.

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