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Spatial distribution of genus *Berberis* from Pakistan: A review over three centuries long historical records

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Key words: *Berberis*, Pakistan, Spatial Distribution, Himalaya, Karakoram, Gilgit-Baltistan, Kashmir, KPK.

Abstract

For the first time, present study gives a composite outlook of the genus *Berberis* from Pakistan with spatial distribution along with estimation of total area under occupation. GE Path, Google Earth and ArcGIS have been used to calculate and project distribution area. Besides online resources, available print material has also been used to explore historical records for documentation. A total of 29 species, subspecies, varieties and forma have been reported from Pakistan covering almost 0.1 million kanals (12,700 acres). According to the results, Gilgit-Baltistan falls on the second having more diversity of *Berberis* spp. and reports equally. We did not find any species reported from province of Sind followed by Islamabad and Baluchistan with least species richness reported. *Berberis* spp. across Pakistan found in mountainous areas with higher density in the Northern Part of Pakistan including provinces of Khyber Pakhtunkhwa (formerly called North-West Frontier Province), Gilgit-Baltistan and Kashmir. Several anomalies continue to exist in morphology-based identification among members of genus *Berberis*. There are fewer species than the reported ones from the country and DNA markers based investigations are important to end such confusion. Overlapping of characters and hybridization are a great cause of mix-up across members of the genus. *Berberis pseudumbellata* subsp. *gilgitica* is endemic to Gilgit-Baltistan and has become critically endangered. Besides serving mountain wildlife as wild-herbal-clinic and dietary supplementation, *Berberis* spp. are great source of ethnomedication and ethnoveterinary for mountainous traditional communities.

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Introduction

Berberis is the most pronounced genus among other ca 16 genera. Out of total 650 species in the entire family, *Berberis* contains more than ca 450 (Tiwari *et al.* 2012; Landrum 1999; Rao *et al.* 1998; Ahrendt 1961). It is one of the most primitive angiosperm (Bruckner, 2000) and has remained as a familiar therapeutic agent among various healthcare systems (Kulkarni & Dhir 2010; Imanshahidi & Hosseinzadeh 2008; Lewis & Ausubel 2006; Srivastava *et al.* 2006a). 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). The family Berberidaceae was first established by A. L. de Jussieu (1789) as 'Berberides' (Tiwari *et al.* 2012).

Berberis is one of the important medicinal plant used as a very common ingredient in herbal medication systems viz; Eastern, Ayurvedic, Unani and modern system of medicines (Sing *et al.*, 2008, Chopra *et al.*, 1981; Chandra and Purohit, 1980). It has been reported useful in treatment of cancer, diabetes, jaundice, enlargement of spleen, AIDS, osteoporosis, cardiovascular ailments, ocular trachoma, hypertension, infectious diseases, cholera, diarrhea, dysentery, eye troubles, leprosy and bone fractures etc. (Khan *et al.* 2013; Sing *et al.* 2008; Asif *et al.* 2007; Fatehi *et al.* 2005; Caraballo *et al.* 2004; Kuo *et al.* 2004; Villinski *et al.* 2003; Janbaza & Gilanib, 2000; Hwang *et al.* 2002; Ivanoska & Philipov, 1996; Koo & Seang, 1996; Chopra *et al.* 1981; Chandra and Purohit, 1980). The roots bark of *B. vulgaris* L has been placed in the secondary list of the *Materia Medica* of British Pharmacopeia and the Pharmacopeia of the United States (Bentley & Trimen 1992).

Members of the genus are mostly restricted to northern hemisphere exhibiting a global distribution with a higher concentration in Asian continent having center in the Himalayan region (Landrum, 1999; Chamberlain & Hu 1975). Moreover, *Berberis* extends

into South America where it has a secondary center of diversity (Landrum 1999). *B. vulgaris* L is native to Europe. Similarly, *B. koreana* Palib has distribution in Korea (Rashmi *et al.* 2008) and *B. holstii* Engl is endemic to the mountains of Eastern and Southern Africa (Maliwichi-Nyirenda *et al.* 2011). *Berberis* population and diversity commonly inhabited regions and countries include Pakistan, China, India, Central and Western Asia, Japan, South-East Asia, Europe, East Africa, North and South America (Rao & Hajra 1993; Chandra & Purohit 1980). Therefore, it is assumed that it has most probably originated in northern hemisphere during Cenozoic period. However, a complete biogeographical study of all genera of the tribe is still lacking (Emadzade & Hörandl 2011; Raven 1973). Few scattered *Berberis* species have been reported from Africa (Ahrendt 1961). According to Li (2010) 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), carpellary anatomic features suggest that Berberidaceae and Ranunculaceae arose by parallel evolution from a Proranalian complex.

Berberis exhibit vulnerability towards environmental and hybridization effects, therefore, it shows extremely high morpho-pathological and phytochemical variation making taxonomic identification difficult (Khan *et al.* 2014; Rao *et al.* 1998a; Chapman 1936; Ahrendt 1961). Overlapping characters, especially in 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).

Present research and review presented for the first time focuses on composite distribution, area calculation, diversity richness calculation, field identification challenges and chronological recording from Pakistan. Study will help researchers, planners, conservationists and taxonomists equally.

Material and methods

The study is based on the data collected from our own research in Central Karakoram National Park, Gilgit-Baltistan, online resources and print material available on *Berberis* spp. from Pakistan (30° 00' N latitude and 70° 00' E longitude). Geographically country presents a profound blend of landscapes varying from plains to deserts, forests, hills, and plateaus ranging from the coastal areas of the Arabian Sea in the south to the mountains of the Karakoram Range in the North (Geo 2014). Country is bordered by India in the East, China in the North-East, Afghanistan and Tajikistan towards North, Afghanistan in the West and Iran in the South-West.

There are four seasons and climate is varied throughout the country, characterized by hot summers and cool or cold chilling winters (Mehreen & Shahina 2013). Western and Northern part of the country holds world's largest mountain ranges viz; Himalaya, Karakoram, Hindukush, Pamir and Sulaiman. Northern part is the key source of fresh water flow in the country and harbor world's largest glacial masses outside poles.

Floro-Political Zonation

Study reveals that there are seven (#7) floro-political zones with respect to administrative and habitation of *Berberis*. These are Gilgit-Baltistan (formerly called Northern Areas), Baluchistan, Khyber Pukhtoonkhaw (formerly called North Western Frontier Province), Kashmir (Azad Jamu and Kashmir), Islamabad (capital territory), Punjab and Sind.

Common taxonomic features of *Berberis*

Average plant (shrubs) reaches to 2.71 m with a maximum height of 3.37 m (Khan *et al.* 2014d). Leaves petiolate, oblong, obovate or elliptic-acute, spinere-serrate, sinulose margins. Both the subspecies are thorny; the flowers were deep/light yellow, hermaphrodite, pollinated by insects or self. Flowers were arranged in loose racemose-subumbellate and corymbose panicles. (Khan *et al.* 2014d; Kulkarni, *et al.*, 2012; Alam 2010; Mehrhoff

et al. 2003; Agrios 1988; Hooker 1982). Major (visible) features of flowers in both subspecies were similar except berry colour (Khan *et al.* 2014d). These features are taken into account from our own field and laboratory based research data and details given in Flora of Pakistan (eFlora 2014; Nasir & Ali 1975; Jafri 1975).

Area distribution calculations

Calculation of overall distribution area has been calculated using Google Earth (2014), Google Earth Pro (2010), GE-Path (v. 1.4.6), MS Excel (v.2010), ArcGIS (v.10.1), ArcGIS (MDA NaturalVue Imagery, 2014) and ArcGIS my maps (online resource, Map, 2014).

Maps extracted (polygons) were transformed into 'kml' used to estimate area (km²) and perimeter using GE Path considering areas as 'large area calculations' and not 'small area calculations'. Latitude and Longitudes (GE Path) were reconfirmed from Google Earth to ensure effective coverage of *Berberis* reported areas, districts and valleys.

Results

Berberis species and their distribution across Pakistan

There are 29 different species (20), subspecies (06), varieties (02) and forma (01) have been reported from various locations of Pakistan (table 1). These species are mostly distributed in the Northern mountainous ranges (Khan *et al.* 2014a; eFlora 2014; Jafri 1975) of Pakistan; however, different species (fig. 2) show varied scope of their distribution (fig. 1). Furthermore, table (#2) encloses all floro-administrative zones and total reports of *Berberis* species. Similarly, table (#3) accumulates complete summary of *Berberis* species reported, habitat of collection, year of exploration and researcher.

Single location inhabitant *Berberis* spp.

At least there are twelve (#12) species exhibit restricted to a single location/province. These species include B. PGI (*B. pseudumbellata* subsp. *gilgitica*), B. B.st (*B.*

stewartiana), B.ul (*B. ulicina*), B.vul (*B. vulgaris*), B.ait (*B. aitchisonii*), B.balu (*B. baluchistanica*), B. Bre (*B. brevissima*), B. Gl (*B. glaucocarpa*); B.hue (*B. huegeliana*); B.Chit (*B. Chitria*), B. Kash (*B. Kashmirana*) and B. roy (*B. royleana*).



Fig. 1. Spatial distribution of *Berberis* species in Pakistan showing different floro-administrative zones. Map creation by Tika Khan 2014.

Four *Berberis* species namely B. PGI (*B. pseudumbellata* subsp. *gilgitica*), B. B.st (*B. stewartiana*), B.ul (*B. ulicina*) and B.vul (*B. vulgaris*) are restricted to Gilgit-Baltistan. One species, B.balu

(*B. baluchistanica*) is restricted to province of Baluchistan, similarly, three (#3) species namely B.ait (*B. aitchisonii*), Bre (*B. brevissima*) and B. roy (*B. royleana*) are only found and reported from Khyber Pukhtoonkawa; four (#4) species show geographical limitation only to Kashmir (Azad Jamu and Kashmir, part held under Pakistan). These species are B. Gl (*B. glaucocarpa*), B.hue (*B. huegeliana*), B.Chit (*B. Chitria*) and B. Kash (*B. Kashmirana*). Most of these species are endemic to their locations.

Berberis distributed across two locations

There are five (#5) species show little wider range than single location *Berberis* species. These species are B.Or (*B. orthobotrys*), B. OrC (*B. orthobotrys capitata*), B. OOr (*B. orthobotrys orthobotrys*), B. jae (*B. jaeschkeana*), B.P (*B. pseudumbellata*). Gilgit-Baltistan and province of Khyber Pukhtoonkawa share three species and subspecies. These are B.Or (*B. orthobotrys*), B. OrC (*B. orthobotrys capitata*) and B. OOr (*B. orthobotrys orthobotrys*). Two remaining species stretch across Khyber Pukhtoonkawa and Kashmir are B. jae (*B. jaeschkeana*) and B.P (*B. pseudumbellata*). However, B.P (*B. pseudumbellata*) has also been found in Gilgit-Baltistan but has been reported in the form of its subspecies.

Table 1. Summary of all reported 29 *Berberis* species, subspecies, varieties and forma from Pakistan, Accepted names of species, subspecies, varieties and forma have been adopted from the Flora of Pakistan.

S #	Accepted Botanical Name (Species, subspecies, variety, forma)	S #	Accepted Botanical Name (Species, subspecies, variety, forma)
1	<i>Berberis aitchisonii</i>	16	<i>Berberis orthobotrys</i>
2	<i>Berberis baluchistanica</i>	17	<i>Berberis orthobotrys</i> subsp. <i>capitata</i>
3	<i>Berberis brandisiana</i>	18	<i>Berberis orthobotrys</i> subsp. <i>orthobotrys</i>
4	<i>Berberis brevissima</i>	19	<i>Berberis pachyacantha</i>
5	<i>Berberis calliobotrys</i>	20	<i>Berberis pachyacantha</i> subsp. <i>pachyacantha</i>
6	<i>Berberis chitria</i>	21	<i>Berberis pachyacantha</i> subsp. <i>zabeliana</i>
7	<i>Berberis glaucocarpa</i>	22	<i>Berberis parkeriana</i>
8	<i>Berberis huegeliana</i>	23	<i>Berberis pseudumbellata</i>
9	<i>Berberis jaeschkeana</i>	24	<i>Berberis pseudumbellata</i> subsp. <i>gilgitica</i>
10	<i>Berberis jaeschkeana</i> var. <i>jaeschkeana</i>	25	<i>Berberis pseudumbellata</i> subsp. <i>pseudumbellata</i>
11	<i>Berberis jaeschkeana</i> var. <i>usteriana</i>	26	<i>Berberis royleana</i>

S #	Accepted Botanical Name (Species, subspecies, variety, forma)	S #	Accepted Botanical Name (Species, subspecies, variety, forma)
12	<i>Berberis kashmirana</i>	27	<i>Berberis sp.</i>
13	<i>Berberis kunawurensis</i>	28	<i>Berberis stewartiana</i>
14	<i>Berberis kunawurensis forma chitrioides</i>	29	<i>Berberis ulicina</i>
15	<i>Berberis lycium</i>		

Berberis distributed across three zones

Five *Berberis* species found across three zones are B.Ca (*B. calliobotrys*), B.Pa (*B. pachyacantha*), B.Pr (*B. parkeriana*), B.Br (*B. brandisiana*) and B.PP (*B. pseudumbellata pseudumbellata*). Gilgit-Baltistan, Khyber Pukhtoonkhawa and Punjab share two species is B.Br (*B. brandisiana*) and B.Pr (*B. parkeriana*); Gilgit-Baltistan, Kashmir and Khyber Pukhtoonkhawa share B.PP (*B. pseudumbellata pseudumbellata*). Moreover, B.Pa (*B. pachyacantha*) ranges over Kashmir, Khyber Pukhtoonkhawa and Punjab. Similarly, B.Ca (*B. calliobotrys*) has been reported from three different zones i.e. Baluchistan, Khyber Pukhtoonkhawa and Kashmir.

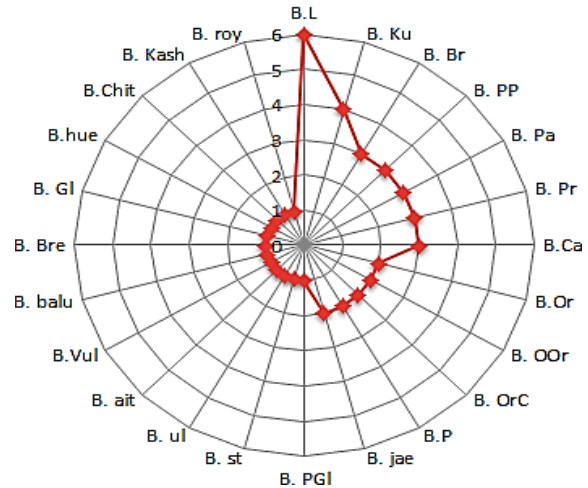


Fig. 2. *Berberis* species and their distribution scope across provinces/major habitat locations.

Table 2. *Berberis* species and their total reports from seven floro-political zones (provinces/major locations) of Pakistan.

S.No.	Province/ Major Location	Berberis Species																							
		B.L	B.Br	B.Or	B.OOr	B.OrC	B.P	B.PP	B.PGI	B.Ku	B.Pa	B.Pr	B.Ca	B.st	B.ul	B.ait	B.Vul	B.balu	B.Bre	B.Gl	B.hue	B.Chit	B.Kash	B.jae	B.roy
1	Baluchistan	1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	4	-	-	-	-	-	-	-	-
2	Gilgit-Baltistan	8	9	6	7	6	-	9	8	1	-	2	5	2	-	1	-	-	-	-	-	-	-	-	-
3	Islamabad	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Kashmir	1	-	-	-	-	1	1	-	1	1	-	1	-	-	-	-	-	-	1	1	1	1	1	-
5	Khyber Pukhtoonkhwa	9	1	1	1	1	3	2	-	3	1	4	8	-	-	4	-	-	1	-	-	-	-	2	1
6	Punjab	1	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Sind	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total Reports	21	11	7	8	7	4	12	8	6	3	7	12	5	2	4	1	4	1	1	1	1	1	3	1
	Species' distribution	6	3	2	2	2	2	3	1	4	3	3	3	1	1	1	1	1	1	1	1	1	1	2	1

Abbreviations: B.L (*B. lyceum*), B.Br (*B. brandisiana*), B.Or (*B. orthobotrys*), B.P (*B. pseudumbellata*), B.PP (*B. pseudumbellata pseudumbellata*), B. PGI (*B. pseudumbellata gilgitica*), B.Ku (*B. kunwarensis*), B.Pa (*B. pachyacantha*), B.Pr (*B. parkeriana*), KNP (Khunjerab National Park), B. OOr (*B. orthobotrys orthobotrys*), B. OrC (*B. orthobotrys capitata*), B.Ca (*B. calliobotrys*), B.st (*B. stewartiana*), B.ul (*B. ulicina*), B.ait (*B. aitchisonii*), B.vul (*B. vulgaris*), B.balu (*B. baluchistanica*), B. Bre (*B. brevissima*), B. Gl (*B. glaucocarpa*); B.hue (*B. huegeliana*); B.Chit (*B. Chitria*), B. Kash (*B. Kashmirana*), B. jae (*B. jaeschkeana*), B. roy (*B. royleana*).

Year	Researcher/ Author	Reported From	Berberis Species																							
			B.L	B.Br	B.Or	B.OOr	B.OrC	B.P	B.PP	B.PGl	B.Ku	B.Pa	B.Pr	B.Ca	B.st	B.ul	B.ait	B.Vul	B.balu	B.Bre	B.Gl	B.hue	B.Chit	B.Kash	B.jae	B.roy
1956	RR Stewart	Queta dist. (Khatuca)																Ö								
1956	RR Stewart	Oghi												Ö												
1956	Shoukat Ali	Karamber			Ö																					
1956	A. Jalis	Queta dist.												Ö												
1956	Shoukat Ali	Gilgit (Darkut-													Ö											
1956	JDA Stainton	Chitral dist. (Mastuj)														Ö			Ö							
1957	E. Nasir	Urak																	Ö							
1957	RR Stewart	Rawalpindi dist.												Ö												
1957	M. Zahur	Swat dist. (Falksar,														Ö										
1958	JDA Stainton	Ziarat																	Ö							
1958	RR Stewart	Kuram Valley,												Ö												
1959	MH Jafri and SI Ali	Rawalpindi dist.									Ö															
1963	Siddiqui, MA.	Baltistan-Sadpara				Ö																				
1963	MA Siddiqui	Baltistan (Sadpara)			Ö																					
1965	Naseeb Khan	Peshawar dist.																		Ö						
1967	E. Nasir and	Sawt Valley												Ö												
1968	AR Beg	Hazara									Ö															
1968	Naseeb Khan	Peshawar dist.												Ö												
1970	M. Qaisar and A.	Loralai, Chutar,-																	Ö							
1970	M. Qaisar and A.	Zhob dist.												Ö												
1971	Beg, AR.	Chitral-Brir												Ö												
1971	Sultan Abedin	Hazara, Dir dist.,												Ö												
1971	AR Beg	Chitral												Ö												
1974	Ghafoor, A. & Butt,	Skardu-Satpara;				Ö			Ö																	
1974	Ghafoor, A.	Naltar 1000 ft							Ö																	
1974	A. Ghafoor and	Gilgit dist., (Basin												Ö												
1974	M. Qaisar	North Waziristan												Ö												
1974	A. Ghafoor	Gilgit (Naltar)								Ö																
1975	Jafri, SMH.																									
1981	Hussain <i>et al.</i>	Chitral				Ö																				
1999	Shinwari and Khan	Islamabad	Ö																							
2000	Kashif M. Sheikh	Naltar Valley							Ö				Ö													
2003	Shinwari and Gilani	Bulashbar valley,	Ö																							
2006	Qureshi <i>et al.</i>	Gilgit to Hunza,	Ö									Ö														
2006	Gilani <i>et al.</i>	Ayubia, Abbotabad	Ö																							
2007	Khan and Khatoon	Bagrot, Haramosh	Ö		Ö	Ö	Ö																			
2007	Hamayun, M.	Sawt Valley	Ö																							
2008	Hussain <i>et al.</i>	Rawalpindi	Ö																							
2009	Alam and Ali	Naltar, Skoro La-												Ö												
2009	Sher wali Khan	Bagrot, Haramosh	Ö		Ö	Ö	Ö	Ö																		
2009	Ahmed <i>et al.</i>	Gilgit-Baltistan	Ö																							
2009	Jan <i>et al.</i>	Dir Kohistan	Ö																							
2009	Qureshi <i>et al.</i>	South Himalaya	Ö																							
2011	Khan <i>et al.</i>	KNP and Shimshal	Ö																							
2011	Hussain <i>et al.</i>	Baluchistan	Ö																							
2011	Haq <i>et al.</i>	Himalaya Pakistan	Ö																							
2011	Sher <i>et al.</i>	Swat Valley	Ö																							
2011	Hussain <i>et al.</i>	Ghanche, Baltistan	Ö																							
2012	Haq, F.	Alai Valley, Khyber	Ö																							
2012	Khan <i>et al.</i>	Naran Valley							Ö																	
2012	Khan <i>et al.</i>	Chitral, Khyber						Ö																		
2013	Alamgeer <i>et al.</i>	Gilgit				Ö																				
2013	Iqbal <i>et al.</i>	Kunhar River	Ö								Ö	Ö	Ö													
2013	Abbas <i>et al.</i>	Naltar valley		Ö		Ö	Ö																			
2013	HUSSAIN, A.,	Skardu-Kuwardu,	Ö																							
2013	Rahman <i>et al.</i>	Gilgit	Ö																							
2013	Awan <i>et al.</i>	Gilgit-Baltistan	Ö																							
2013	Khan <i>et al.</i>	Chitral, Khyber						Ö																		

Year	Researcher/ Author	Reported From	Berberis Species																							
			B.L	B.Br	B.Or	B.OOr	B.OrC	B.P	B.PP	B.PGl	B.Ku	B.Pa	B.Pr	B.Ca	B.st	B.ul	B.ait	B.Vul	B.balu	B.Bre	B.Gl	B.hue	B.Chit	B.Kash	B.jae	B.roy
2013	Mehmood <i>et al.</i>	Leepa Valley						Ö																		
2014	Bano <i>et al.</i>	Skaradu															Ö									
2014	Khan <i>et al.</i>	Gilgit-Baltistan								Ö																
2014	Khan <i>et al.</i>	Gilgit-Baltistan							Ö	Ö																
2014	Khan <i>et al.</i>	Gilgit-Baltistan							Ö	Ö																
NM	Huegele	Kashmir																			Ö					

Abbreviations: B.L (*B. lyceum*), B.Br (*B. brandisiana*), B.Or (*B. orthobotrys*), B.P(*B. pseudumbellata*), B.PP (*B. pseudumbellata pseudumbellata*), B. PGl (*B. pseudumbellata gilgitica*), B.Ku (*B. kunwarensis*), B.Pa (*B. pachyacantha*), B.Pr (*B. parkeriana*), KNP (Khunjerab National Park), B. OOr (*B. orthobotrys orthobotrys*), B. OrC (*B. orthobotrys capitata*), B.Ca (*B. calliobotrys*), B.st (*B. stewartiana*), B.ul (*B. ulicina*), B.ait (*B. aitchisonii*), B.vul (*B. vulgaris*), B.balu (*B. baluchistanica*), B. Bre (*B. brevissima*), B. Gl (*B. glaucocarpa*); B.hue (*B. huegeliana*); B.Chit (*B. Chitria*), B. Kash (*B. Kashmirana*), B. jae (*B. jeschkeana*), B. roy (*B. royleana*).

Berberis: Geographical area coverage

Various *Berberis* species have been reported from Baluchistan to Gilgit-Baltistan and Punjab. Different habitats explored by several researchers from different parts of the country were estimated breaking into seven (#7) floro-administrative zones show that *Berberis* species are distributed over an area of almost 0.1 million square kilometers across Pakistan (table 4). Province of Khyber Pukhtoonkhawa shows the

largest area coverage followed by province of Baluchistan and Gilgit-Baltistan (table 4). This area coverage does not reflect the exact geographical ranges or distribution but an estimate as calculated using Google Earth maps. To make calculations precise, maximum magnification of pixels has been used. Moreover, these calculations are not alternate to area of occupancy (AOO) or extent of occurrence (EOO).

Table 4. Summary sheet of total number of *Berberis* reports from provinces/major locations, total species reported, total researchers reported, total species diversity reported, area covered in each location and total perimeter of total covered area by *Berberis* species.

	Province/Major Location	Total Reports	Total spp. reported	Total Researchers Reports	Spp. Richness %	Area (km ²)	Perimeter (km)
1	Baluchistan	8	3	7	6.1	29351	803
2	Gilgit-Baltistan	46	14	24	28.6	17401	2066
3	Islamabad	1	1	1	2.1	897	147
4	Kashmir	11	11	10	22.5	12226	919
5	Khyber Pukhtoon Khaw	39	15	25	30.6	34273	1324
6	Punjab	5	5	4	10.2	8240	540
7	Sind	0	0	0	0	0	0
	TOTAL	110	49	71	100	102388	5799

Berberis species richness

Calculations using reported data over the last three centuries show that province of Khyber Pukhtoonkhaw shows the maximum *Berberis* species diversity with 30.6% (n=15). Gilgit-Baltistan falls on

the second for having number of reported *Berberis* species with 28.6% (n=14) richness. Azad Jamu and Kashmir exhibited third highest number of different *Berberis* species (n=11, 22.5%). Study reveals that there is no single species found in province of Sind.

Discussion

Berberis is one of the most important medicinal plant genus serving human, domesticated animals and wildlife equally for centuries. It has been one of the active therapeutic agent in almost all traditional healthcare systems and present day medication. Present study and review is unique for several reasons including parameters taken into account. History of Berberis exploration started when Aitchison reported *Berberis calliobotrys* in 1879 from Kuram Valley near Afghanistan. Since then, more than 111 reports are available regarding twenty four (#24) Berberis species from Pakistan.

Based on our research conducted and published earlier (Khan *et al.* 2014, Khan *et al.* 2014a, Khan *et al.* 2014b, Khan *et al.* 2014c, Khan *et al.* 2014d, Khan *et al.* 2014e) from Central Karakoram National Park (CKNP), Gilgit-Baltistan, we are doubtful regarding the total number (n=29) of Berberis species highlighted in Flora of Pakistan (Jafri, 1975). We are with the opinion that like CKNP where 14 species were reported, our morphological characterization and similarity index derived for different Berberis species supports for only two subspecies of Berberis pseudumbellata instead of fourteen (n=14). Similarly, we recommend for detailed investigation of genus with quantification and measureable parameters to impact on field based difficulty in identification. However, to remove such confusion forever, DNA based characterization is important. This error may be due to following potential reasons; 1) overlapping characters which are an inherent feature of *Berberis* species under the influence of environmental conditions and hybridization, 2) Lack of quantifiable and reliable 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).

Area under Berberis species across Pakistan is done for the first time. These calculations have been made in absence of Geographic Positioning System (GPS) coordinates of each Berberis reported location or its habitat or its total extent. However, it gives a preliminary base to encourage calculations of AOO and EOO for each species reported.

This study also support idea of its origin and primary centre being Himalaya, however, B. pg. is still needs to investigate its origination and speciation in the area.

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