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Evaluation and detailing of taxonomic and historical perspectives on genus *Berberis* from Pakistan

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Abstract

This review, besides detailed taxonomic description of genus, presents a chronology of each 29 Berberis species reported from CKNP, Gilgit-Baltistan and Pakistan. Furthermore, review revealed that the actual number of Berberis species reported from any area of Pakistan might be less than the stated one. There are thirteen (n=13) species and subspecies reported from CKNP and fourteen (n=14) from entire Gilgit-Baltistan province, however, morphological relatedness analysis of Berberis species from CKNP revealed that there are only two subspecies of a single species i.e. *B. pseudumbellata*. However, these confusions, to a greater extent inherited across most of the Berberis species because of morphological changes over age, edaphic variations, vulnerable overlapping characters under influence of environment and hybridization. A detailed but inclusively integrated revision of the genus is need of the time. Until then, acute misinterpretations and uncertainty will continue to exist. Historically such revisits have led to revise and address such issues. Similarly, Landrum (1999) recognized only 20 Berberis species out of the sixty (n=60) reported by Ahrendt (1961) from Chile (United States).

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Introduction

Berberis is a major genus in dicotyledonous woody plants family Berberidaceae. Different taxonomists have reported disparate number of species and in the family likewise species in the genus. For many, family comprises upon *ca*. 17 genera containing 650 species (Landrum 1999; Chamberlain and Hu 1975), while for several others (Adhikari, 2010; Mabberley, 2008) there are 14 genera and *ca*. 715 species. Furthermore, Whetstone *et al*. (1997) and Nickol (1995) are in favour of 15 and 13 genera with *ca*. 650 and 570 species respectively in the family. Similarly, according to Ahrendt (1961) and Adhikari (2010), Berberis includes *ca*. 450 (excluding *Mahonia* ca. 100) and more than 500 (inc. *Mahonia*) species correspondingly. Berberis is the largest woody plant genus of the basal eudicots (Frodin 2004).

In view of Jafri (1975), family Berberidaceae is represented by 3 genera and c.20 species from Pakistan, however, with new additions it is Twenty Nine (29) species (20 species, 6 subspecies, 2 varieties, 1 forma) at present. Fourteen (14) have been reported from Central Karakoram National Park (CKNP) and Gilgit-Baltistan (GB) (Khan *et al*. 2014). Though, the actual number of species may be smaller (Adhikari, 2010). Landrum (1999) recognized only 20 out of the 60 species reported by Ahrendt (1961) from Chile (United States). Landrum (1999) reduced the number of Berberis species in Chile through synonymy. Similarly, fourteen (14) species reported do not reflect the genuine number of species and according to Khan *et al*. (2014) this is limited only two (2) subspecies of *Berberis pseudumbellata*. Khan *et al*. (2014) challenged previous number on the basis of their morphological similarity index which does not exhibit any significant difference to support an idea of fourteen or even less species. Such confusion may be due to its high morphological variations (Rao *et al*. 1998; Ahrendt 1961) and overlapping characters particularly in leaves, flower, berry colour, berry size which make their identifications confused. In some species, leaf texture and serrations are affected by season, age of the plant and other environmental forces (Tiwari and Adhikari 2011; Rao *et al*. 1998).

Berberis is one of the most important and prominent genus found across almost all mountainous vegetation types in Pakistan, growing from 1400 m (4600 ft)-3500 m (11500 ft). *Berberis lycium*, *Berberis calliobotrys* and *Berberis baluchistanica* found at the lowest height and *Berberis pseudumbellata* subspecies *gilgitica* at highest elevations in the North across Alpine and subalpine ranges in Gilgit-Baltistan (Khan *et al*. 2014a; Alam and Ali, 2010).

Since 1950s, taxonomists carry conflicting approaches towards identity of Berberis (simple-leaved) and Mahonia (compound-leaved). Contrary to many authors (Hutchinson, 1959; Ahrendt, 1961; Airy Shaw, 1965; Takhtajan, 1969) several put them together (Landrum, 1999; Laferriere, 1997; Whittemore 1997,) on the basis of insignificant differences in number of chromosomes (Derman, 1931), floral anatomy (Terabayashi, 1978), seedling morphology (Terabayashi, 1987) and chloroplast DNA (cpDNA) inverted repeat (IR) region (Kim and Landrum, 2004) studies. This thesis does not include *Mahonia* and the word (taxon) Berberis refers to *Berberis sensu stricto* (*s.s.*) as used to refer simple-leaved Berberis.

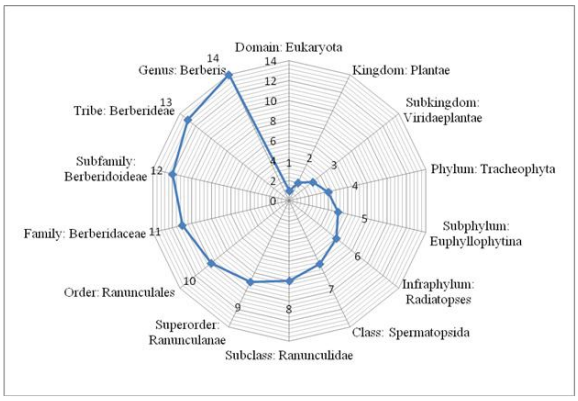

Fig. 1. Taxonomic hierarchy of genus Berberis projected using a Radar graph. Numbers exhibit level of each taxon and its distance from other taxa.

Different taxon has been displayed graphically using radar with markers (Fig. 1). Though, various taxa carry a history of their introduction i.e. Domain: Eukaryota was first introduced by Whittaker & Margulis (1978) to represent eukaryotes. Similarly, Kingdom: Plantae (Haeckel, 1866 – Plants), Subkingdom: Viridaeplantae (Cavalier-Smith, 1981), Phylum: Tracheophyta (Sinnott, 1935 ex Cavalier-Smith, 1998 - Vascular Plants), Subphylum: Euphyllophytina, Infraphylum: Radiatopses (Kenrick & Crane, 1997), Class: Spermatopsida (Brongniart, 1843), Subclass: Ranunculidae (Takhtajan Ex Reveal, 1992), Superorder: Ranunculanae (Takhtajan Ex Reveal,1992), Order: Ranunculales (Dumortier, 1829), Family: Berberidaceae (Durande, 1782, nom. cons. – bayberries), Subfamily: Berberidoideae, Tribe: Berberideae and Genus: Berberis (C. Linnaeus, 1753 - Barberry, Oregon-grape)

During early half decade of the first decade of twentieth century (1904-1905), Schneider described infra-generic classification of the genus. He categorized into 21 sections, 32 subsections and designated 155 species (Adhikari *et al.* 2010). In 1908, on the basis of their origin, he further divided species into two sub-generic clusters; these are Septentrionales of Eurasia and Australes of South American (Ahrendt 1961, Landrum 1999, Adhikari *et al.* 2012).

In 1961, Ahrendt published his revised monograph classifying genus into 33 sections, 50 sub-sections and included 496 species (Adhikari, 2010). However, Landrum (1999) questioned his classification based on an unrealistically narrow definition of species and recognized only 20 out of 60 species described by Ahrendt (1961) from Chile (United States). Ahrendt's species concept was based on uncertain characters such as the stem colour and leaf margin. Therefore, actual number of Berberis species is likely to be considerably smaller than the 496 he stated (Adhikari 2010).

Several researchers have published their research delineating different aspects of Berberis since the last century but there was a dire need of a composite review of literature and its evaluation regarding genus Berberis. In this paper we have attempted to consolidate the taxonomic and chronological developments with respect to genus Berberis. This focused detailing is unique for being made for the first time in the history of the genus. This paper will serve as a reference material for researchers with the similar interest with comprehensive details on the subject.

Material and methods

Geographical scope

This review deals with the overall details of genus Berberis from Pakistan with a special focus on historical and taxonomic developments. Pakistan come into existence in 1947 while history of genus Berberis goes well beyond the political establishment.

Data collection and analysis

Review relies on available print and online subject related resources. Various software packages have been used for data processing and analysis including Microsoft Excel 2013, SPSS v. 16 (Special package for social sciences).

Results

Berberis: Name genesis to classification

In 1753, Linnaeus described the genus *Berberis* for the first time in *Species Plantarum* (Adhikari, 2010). According to Quattrocchi (1947), the name Berberis derives from Arabic name 'Berberys', used for the fruit. Similarly, in 1789, A. L. de Jussieu established family Berberidaceae for the first time as 'Berberides' considering it as one of the most primitive dicotyledonous Angiosperms (Bruckner, 2000).

Berberis in Pakistan: A chronological perspective

Chronological order of collection (report) of each Berberis species explored from Pakistan has been given in table 1. Aitchison (1879) was the first to describe *Berberis* from Pakistan. He reported *B.*

calliobotrys from Kuram Valley near Afghanistan (Jafri, 1975). Details of Berberis species collection (report) for the first time from Gilgit-Baltistan have been described in table 2. From Gilgit-Baltistan, W. Koelz was the pioneer to report Berberis in 1936 from Sadpara (4000 m), Baltistan. Similarly, Stewart and Stewart (1939) were the first collectors of Berberis species from the study area, now fall within the geography recently declared as Central Karakoram National Park (CKNP). Details are given in table 3. Jafri (1975) was the first to publish account of genus Berberis (Berberidaceae) from Pakistan in 1975 in the name of 'Flora of Pakistan' from the department of Botany, University of Karachi.

Table 1. Chronological order (history) of Berberis species (n=24) collected for the first time from Pakistan (FOP, 2014).

Year	*Berberis spp.*	Collector/Reporter	Location/Collection Site
1879	*B. calliobotrys*	Aitchison	Kuram Valley near Afghanistan
1917	*B. brandisiana*	RR Stewart	Rawalpindi dist.
1918	*B. pachyacantha*	RR Stewart and ID Stewart	Rawalpindi dist. (Muree)
1919	*B. jaeschkeana*	RR Stewart and ID Stewart	Kashmir
1920	*B. pseudumbellata* subsp. *pseudumbellata*	RR Stewart and ID Stewart	Hazara dist.
1939	*B. stewartiana*	Stewart, RR. & ID.	Gilgit Rd. 2800m
1939	*B. orthobotrys* subsp. *orthobotrys*	Stewart, RR. & ID.	Astor, Gurikot, Gilgit 2700m
1939	*B. baluchistanica*	M. Nath	Sibi dist. (Ziarat)
1939	*B. lyceum*	A. Latif	Hazara dist.
1939	*B. kashmirana*	Ludlow	Kashmir
1939	*B. orthobotrys*	RR Stewart and ID Stewart	Gilgit, Gurikot, Gudai, Kashmir
1940	*B. ulicina*	Stewart, RR.	Skardu-satpara 3800mBaltistan Thale La 300m
1943	*B. glaucocarpa*	Ahrendt	kashmir (western himalaya)
1943	*B. chitria*	Ludlow and Sherrif	Himalaya and Kashmir
1952	*B. kunwarensis*	RR Stewart	Swat
1952	*B. royleana*	RR Stewart	Swat dist (Kalam)
1953	*B. aitchisonii*	RR Stewart and A. Rehman	KPK (Batain)
1955	*B. orthobotrys* subsp. *capitata*	Nisar, E & Webster GL	Hushe 4000m, Astor; skardu
1956	*B. parkeriana*	RR Stewart	Oghi
1965	*B. brevissima*	Naseeb Khan	Peshawar dist.
1974	*B. pseudumbellata* subsp. *gilgitica*	Ghafoor, A. & Butt, ZL.	Skardu-Satpara;
2012	*B. pseudumbellata*	Khan *et al.*	Naran Valley
2014	*B. vulgaris*	Bano *et al.*	Skaradu
NM	*B. huegeliana*	Huegele	Kashmir

Table 2. Chronological order (history) of Berberis species (n=12) collected/reported for the first time from Gilgit-Baltistan, Pakistan (FOP, 2014).

Year	*Berberis spp.*	Collector/Reporter	Reported from
1936	*B. brandisiana*	W. Koelz	Sadpara-Skardu, Baltistan
1939	*B. orthobotrys orthobotrys*	Stewart, RR. & ID.	Gilgit 2700m ; Astor, Gurikot,
1940	*B. ulicina, B. brandisiana, B. pseudumbellata* subsp. *pseudumbellata*	Stewart, RR.	Burzil; Baltistan Thale La 300m
1974	*B. pseudumbellata* subsp. *gilgitica*	Ghafoor, A.	Naltar 10000 ft
2000	*B. parkeriana*	Kashif M. Sheikh	Naltar Valley
2006	*B. kunwarensis, B. lyceum*	Qureshi *et al.*	Gilgit to Hunza, Gilgit, Nomal, Naltar Kargah
2007	*B. orthobotrys* subsp. *capitata*	Khan and Khatoon	Bagrot, Haramosh
2012	*B. pseudumbellata, B. orthobotrys*	Gul, N., Khan, MZ.	CKNP

Table 3. Chronological order (history) of Berberis species (n=11) collected/reported for the first time from study area (CKNP-Naltar, Gilgit-Baltistan, Pakistan) (FOP, 2014).

Year	*Berberis spp.*	Collector/Reporter	Reported from
1939	*B. orthobotrys* subsp. *orthobotrys*	Stewart, RR. & ID.	Gilgit 2700m ; Astor, Gurikot,
1940	*B. ulicina, B. brandisiana, B. pseudumbellata* subsp. *pseudumbellata*	Stewart, RR.	Burzil; Baltistan Thale La 300m
1955	*B. orthobotrys* subsp. *capitata*	Nisar and Webster	Hushe Valley
1974	*B. pseudumbellata* subsp. *gilgitica*	Ghafoor, A.	Naltar 10000 ft
2000	*B. parkeriana*	Kashif M. Sheikh	Naltar Valley
2006	*B. kunwarensis, B. lyceum*	Qureshi *et al.*	Gilgit to Hunza, Gilgit, Nomal, Naltar Kargah
2012	*B. pseudumbellata, B. orthobotrys*	Gul, N., Khan, MZ.	CKNP

Discussion

There are 13 species and subspecies reported from CKNP. Similarly, 14 species and subspecies have been described from entire Gilgit-Baltistan province and 29 in total from Pakistan so far. However, studies and analysis carried out on morphological relatedness of Berberis species from CKNP revealed that there are only two subspecies of a single species i.e. B. pseudumbellata (Khan *et al.* 2014). Similarly, Landrum (1999) recognized only 20 Berberis species out of the sixty (n=60) reported by Ahrendt (1961) from Chile (United States).

Based on the case study of Khan *et al.* (2014) and similar investigation by the same research group confirm that the actual number of *Berberis* species reported from any area of Pakistan might be less than the stated one. Therefore, we suggest and recommend a detailed but inclusively integrated revision of the genus is important. Until then, acute misinterpretations and uncertainty will continue to

exist. Historically such revisits have led to revise and address such issues.

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