



RESEARCH ARTICLE

Assessment of diversity in the genus *Berberis* L. (Berberidaceae) in Pindari Valley, Uttarakhand

Ravindra Kumar^{1,2}, Poushali Dey^{1,2}, Khooshboo Yadav¹ & Priyanka Agnihotri^{1,2*}

¹Plant Diversity, Systematics & Herbarium Division, CSIR–National Botanical Research Institute, Rana Pratap Marg, Lucknow 226 001, India

²Academy of Scientific and Innovative Research (AcSIR), Ghaziabad–201002, India

*Email: priyagni_2006@yahoo.co.in



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Abstract

Pindari Valley, a part of the buffer zone of Nanda Devi Biosphere Reserve, is situated in Uttarakhand and covers an area of about 339.36 km². The genus *Berberis* L. comprises of ca 622 taxa distributed worldwide, 55 taxa in India out of which 32 taxa are reported from Uttarakhand. Ongoing studies on the floristic diversity of Pindari Valley in Uttarakhand revealed a total of 12 species of *Berberis* viz. *B. affinis*, *B. asiatica*, *B. aristata*, *B. chitria*, *B. canadensis*, *B. floribunda*, *B. glaucocarpa*, *B. jaeschkeana*, *B. kunawurensis*, *B. lycium*, *B. pseudumbellata* and *B. umbellata* from the Valley, which represents highest diversity in Uttarakhand. A brief description, updated nomenclature, key to the species, phenology, habitat, distribution, IUCN conservation status and representative photographs are provided in the present communication.

Keywords

Angiosperm taxonomy, *Berberis*, Pindari Valley, Uttarakhand, Western Himalaya

Introduction

The Kumaon Himalaya has been a reservoir of enormous natural resources which provides direct and indirect benefits to mankind (1). Such a region in Kumaon, Pindari Valley houses the most diverse and fascinating flora quite different from other peaks in the region. Pindari Valley is a part of the buffer zone of Nanda Devi Biosphere Reserve, situated in Uttarakhand and covers an area of about 339.36 km², lying between an elevational range of 1500 m to 4200 m. Different climatic conditions prevailing in subtropical to alpine zones supports vast plant diversity. The Pindari Valley region has three types of forests, the temperate forest, which is divided into two subcategories i.e., broad-leaved montane forests and coniferous montane forests, mainly lying in between 2000–3000 m a.s.l., the sub-alpine forests lying between 3000–4000 m a.s.l and the alpine meadows in between the 3300–4500 m a.s.l. (2).

The genus *Berberis* L. is the largest genus of the family Berberidaceae, characterized by simple-leaved deciduous or evergreen shrubs, 1–3-armed spines structures at the stem nodes (3–6). It comprises about 622 taxa worldwide (7, 8), distributed in semiarid, temperate and alpine habitats of the northern hemisphere (3, 4). In India, the genus consists of ca 55 taxa, mainly confined to the Himalayan region, however, a few species are also reported from the Western Ghats and the Deccan-Peninsular region (9, 10). At present, a total of ca 32 taxa of the genus *Berberis* have been reported

from Uttarakhand (11, 12), including 13 species from different zones of Kumaon Himalaya (13).

The present study is an outcome of the ongoing floristic studies in Pindari Valley, which have been undertaken to assess the available plant diversity and document their conservation status for biodiversity management. This region has not yet been fully explored and only a very few workers. Botanical trips to document the plant diversity of this area (14, 15). The current research sheds light on the taxonomy and diversity of the genus *Berberis* L. as well as the distribution and phenology of each taxon in the Valley. Based on field surveys, previous literature and herbarium specimen data, the genus *Berberis*, locally known as 'Kilmora' is determined to be one of the largest genus in the Pindari Valley and plays an important role in the forest ecosystem.

Materials and Methods

This work is based on authors observation during field trips of the Pindari Valley in different seasons of 2021-22 along with the examination of herbarium specimens housed in the following herbaria: Botanical Survey of India, Northern Regional Centre, Dehra Dun (BSD), Indian Council of Forestry Research and Education, Dehra Dun (DD) and CSIR-National Botanical Research Institute, Lucknow (LWG) (acronyms according to Thiers, 2022) (16). Standard procedure was followed for the preparation of herbarium specimens; same were deposited at LWG (17). Identification of taxon has been done through the consultation of relevant taxonomic literature and herbarium specimens. The nomenclature of the plant species was updated using IPNI (18) and Plants of the world online (9). Distribution map was prepared through DIVA-GIS program (19). The conservation status of the *Berberis* species was checked using IUCN red-list and other concerned literature (20-22).

Results and Discussion

About 55 taxa of *Berberis* L. are recorded from India, out of which 32 taxa are reported from Uttarakhand; meanwhile we have reported 12 species from Pindari Valley at an altitude range of 2200 to 3200 m., showing maximum diversity of genus *Berberis* in Uttarakhand. The species of *Berberis* in the Pindari Valley include *B. affinis*, *B. asiatica*, *B. aristata*, *B. chitria*, *B. canadensis*, *B. floribunda*, *B. glaucocarpa*, *B. jaeschkeana*, *B. kunawurensis*, *B. lycium*, *B. pseudumbellata* and *B. umbellata*. The scanned herbarium images of each taxa and field photographs of nine species have been provided (Fig. 1-4).

Taxonomic treatment

***Berberis* L.** (Sp. Pl. 330. 1753).

Key to the species of *Berberis*, recorded from Pindari Valley (10, 11).

- 1 a. Evergreen shrub..... 2
- 1 b. Deciduous shrub.....10

- 2 a. Berries red or purple..... 3
- 2 b. Berries bluish black.....8
- 3 a. Style absent*B. umbellata*
- 3 b. Style conspicuous (0.5-1.5 mm).....4
- 4 a. Stem pubescent *B. chitria*
- 4 b. Stem glabrous..... 5
- 5 a. Leaf lamina narrow, 4 × width of lamina..... *B. affinis*
- 5 b. Leaf lamina broader, 2 × width of lamina..... 6
- 6 a. Spine solitary or absent *B. floribunda*
- 6 b. Spine trifid7
- 7 a. Young shoot green *B. aristata*
- 7 b. Young shoot purple..... *B. canadensis*
- 8 a. Leaves thick, coriaceous with conspicuous veins.....
.....*B. asiatica*
- 8 b. Leaves thin, sub coriaceous with obscure veins.....9.
- 9 a. Petals longer than inner sepal.....*B. glaucocarpa*
- 9 b. Petals shorter than inner sepal*B. lycium*
- 10 a. Flowers 15 - 20 mm in diameter*B. jaeschkeana*
- 10 b. Flowers 4 - 11 mm in diameter11
- 11 a. Inflorescence panicle *B. kunawurensis*
- 11 b. Inflorescence sub-umbellate*B. pseudumbellata*

Berberis affinis G. Don, Gen. Hist. 1:115. 1831; Osmaston, Forest Fl. Kumaon 18. 1927; R.R. Rao *et al.* in Rheede 8(1): 23. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 612. 2012; Pusalkar & S.K.Srivast., Fl. Uttarakhand 1: 441. 2018.(Fig. 1A)



Evergreen shrubs. Stem glabrous, pale yellow terete or subangled; internodes 4–5 cm long; spines trifid, 0.3–0.5 cm long. Leaves 3–7 × 1–2 cm, oblanceolate, narrowly acuminate at apex, margin entire. Inflorescence racemose, 11–22-flowered, upto 8 cm long, including peduncle 10–20 mm long. Flowers 8–10 mm in diameter. Berries 8–10 mm, ovoid, stylose with 1 mm long style.

Flowering & Fruiting

March – August.

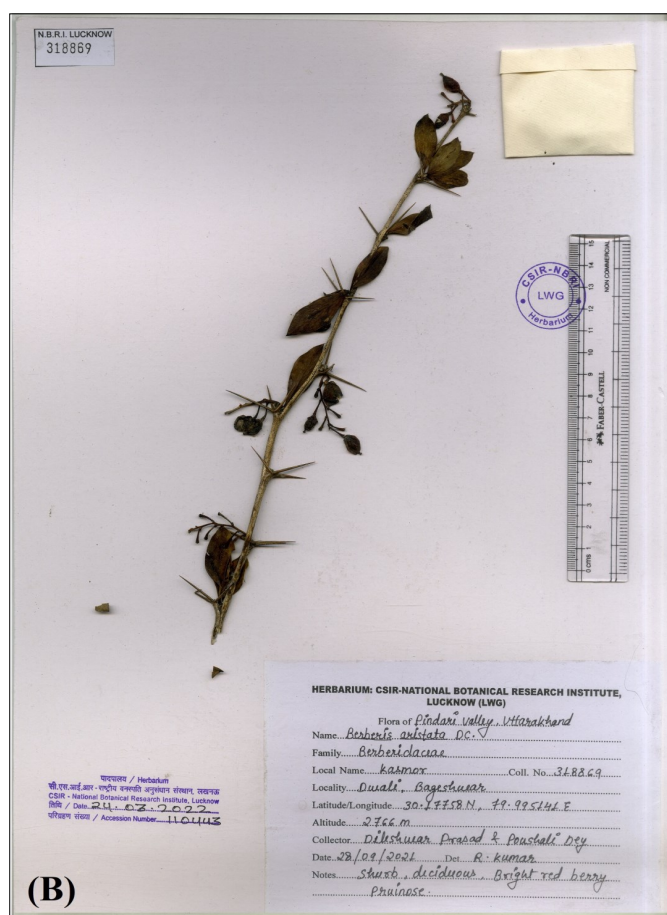
Distribution

INDIA [Western Himalaya: Uttarakhand (Kumaon)].

Representative specimens

Almora, Dwali, 9000 ft. [2743.2 m], July 1920, *W.J. Lambert s.n.* 24049 (DD!).

Berberis aristata DC., Syst. Nat. 2: 8. 1821; Hook. f. & Thoms. in Hook. f., Fl. Brit. India 1: 110. 1872 *p.p.*; Osmaston, Forest Fl. Kumaon 20. 1927; R.R. Rao *et al.* in Rheede 8: 24, f. 6. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 612. 2012; Pusalkar & S.K. Srivast., Fl. Uttarakhand 1: 443. 2018. (Fig. 1B).



Evergreen shrubs 1–3 m tall. Stems glabrous, yellowish brown, terete; internodes 3–4 cm long; spines trifid upto 2 cm long. Leaves 2.5–3.0 × 1–2 cm, obovate elliptic, acute apex, margins entire. Inflorescence raceme 10–20 flowered, 4–8 cm long, including peduncle 10–30 mm. Flowers 10–13 mm in diameter. Berries 8–12 × 5–7 mm, ovoid to oblong, bright red, slightly pruinose, stylose with 1mm long style.

Flowering & Fruiting

May – October.

Distribution

INDIA [Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Sikkim, Tamil Nadu and Uttar Pradesh], BHUTAN and NEPAL.

IUCN Red List status

Least Concern (LC).

Representative specimens

Phurkia - Dwali, 3000–3500 m, 25 September 1957, *T.A. Rao* 4608 (BSD!); Uttarakhand, Pindari Valley, Dwali, 30.177584N, 79.995141E, 2766 m, 28 September 2021, *D. Prasad & P. Dey* 318869 (LWG!).

Berberis asiatica Roxb. ex DC., Syst. Nat. 2: 13. 1821; Hook. f. & Thoms. in Hook. f., Fl. Brit. India 1: 110. 1872 *p.p.*; Duthie, Catl. Pt. Kumaon 8. 1906; Osmaston, Forest Fl. Kumaon 20. 1927; R.R. Rao *et al.* in Rheede 8: 52, f. 15. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 613. 2012; Pushalkar & S.K. Srivast., Fl. Uttarakhand 1: 444. 2018. (Fig. 1C).



Evergreen shrubs. Stems glabrous, pale yellow, terete; internodes 4–5 cm long; spines trifid, central spine longer upto 2 cm long. Leaves 4–5 × 2–3.5 cm, obovate, obovate, thickly coriaceous, apex obtuse, margin spinulose. Inflorescence fascicled, corymbose 10–15 flowered, 4–6 cm long. Flower yellow. Berries 8–12 × 5–6 mm, oblong-ovoid

to ellipsoid, pruinose, pink to red, stylose with upto 1 mm long style.

Flowering & Fruiting

March - July.

Distribution

INDIA [Arunachal Pradesh, Bihar, Himachal Pradesh, Madhya Pradesh, Meghalaya, Sikkim, Uttarakhand and West Bengal], AFGHANISTAN, BHUTAN, CHINA and NEPAL.

Representative specimens

Uttarakhand, Pindari Valley, Khati, 30.114397N, 79.942926E, 2248 m, 04/07/2021, R.Kumar and S.Tiwari 318872 (LWG!).

Berberis canadensis Mill. Gard. Dict. ed. 8: 2. 1768.

Berberis macracantha Schrandt in Linnaea 12: 366. 1838; Rao *et al.* in Rheede 8: 115. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 612. 2012; Pusalkar & S.K.Srivast., Fl. Uttarakhand 1: 457. 2018. (Fig. 1D).

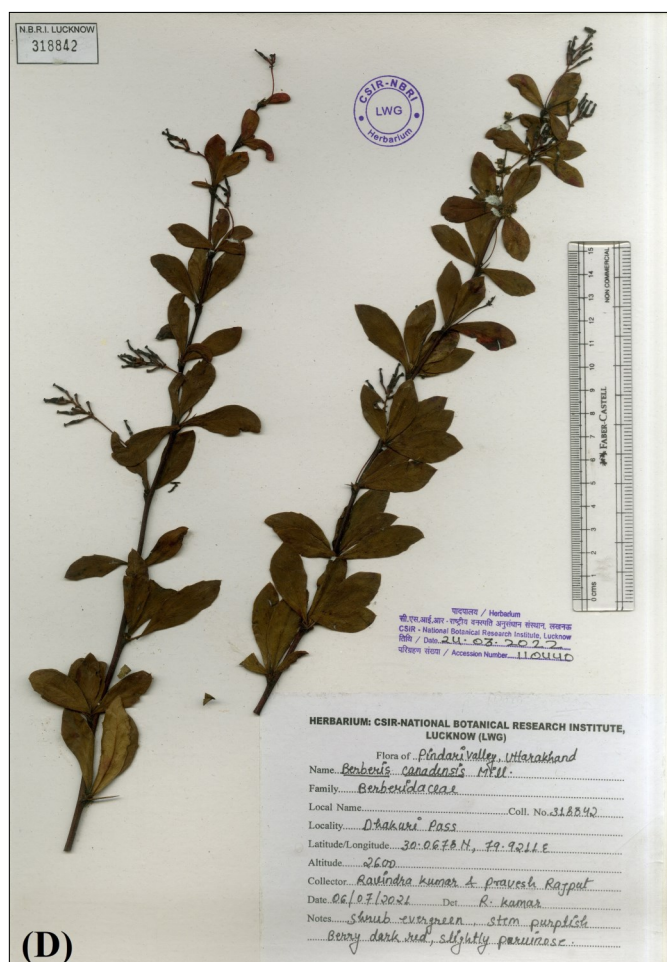


Fig. 1. A. *Berberis affinis* [©ICFRE Dehradun (DD). Reproduced with the consent of the ICFRE, Dehradun], **B.** *Berberis aristata*, **C.** *Berberis asiatica*, **D.** *Berberis canadensis*.

Evergreen shrubs upto 2 m tall. Stem glabrous, young shoot purplish, terete; internodes 3-4 cm long; spines trifid 1-2 cm long. Leaves 3-4 × 1-1.5 cm, obovate-elliptic, apex mucronate, margin entire. Inflorescence racemose, loose, 10-20 flowered, peduncles 2-3 cm long. Flower yellow. Berries 8-10 × 1-3 mm, dark red, ellipsoid, slightly pruinose, stylose with upto 1 mm long style.

Flowering & Fruiting

June - October.

Distribution

INDIA [Western Himalaya: Uttarakhand] and EUROPE.

Representative specimens

Uttarakhand, Pindari Valley, Dhakuri, 30.0678 N, 79.9211E, 2600 m, 06/07/2021, R.Kumar and P.Rajput 318842 (LWG!).

Berberis chitria Buch.-Ham. ex Lindl. in Bot. Reg. 9: t. 729. 1823; Duthie, Catl. Pt. Kumaon 8. 1906; Osmaston, Forest Fl. Kumaon 21. 1927; Rao *et al.* in Rheede 8: 18, f. 5. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70.2007; U.L. Tiwari *et al.* in Check List 8(4): 612.2012; Pushalkar & S.K.Srivast., Fl. Uttarakhand 1: 445. 2018. (Fig. 2A).



Evergreen shrubs 2-4 m tall. Stems pubescent, terete or angled, internodes upto 4 cm long; spines solitary 2 cm long. Leaves 3-5 × 1-2 cm, obovate or elliptic, base cuneate, margin entire or rarely spinulose. Inflorescence 8-20 flowered, 5-10 cm long, corymbose or paniculate. Flowers yellow 2 cm in diameter. Berries 10-12 × 14-6 mm, red or red brown, narrowly ovoid or oblong to ellipsoid, epruinose, stylose with 1-1.5 mm long style.

Flowering & Fruiting

April - September.

Distribution

INDIA [Western Himalaya: Jammu & Kashmir to Uttarakhand] and NEPAL.

Representative specimens

Uttarakhand, Almora, Between Loharkhet to Dhakuri, 8000 ft, 22 May 1972, *K.M Balapure & AP Pandey* 91503 (LWG!); Khati, 30.06844N, 79.56557E, 2248 m, *T Husain & Party* 262075 (LWG!); Kharkia, 30.1176 N, 79.9168E, 2400 m, 05 July 2021, *R. Kumar and S. Sharma* 318854 (LWG!).

Berberis floribunda Wall. ex G.Don, Gen. Hist. 1: 115. 1831; Rao *et al.* in Rheedea 8: 23. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 612. 2012; Pushalkar & S.K.Srivast., Fl. Uttarakhand 1: 449. 2018.(Fig. 2B).



Evergreen shrubs upto 4 m tall. Stems glabrous, pale yellow, sub terete; internodes 5 cm long; nodes swollen; spines absent. Leaves 5-7 × 1.5-2.5 cm, lanceolate to elliptic, clustered at each node on swollen nodes, base attenuate, apex mucronate, margins spinulose. Inflorescence racemose panicle 10-25 flowered, 7 cm. Flower pale yellow. Berries 5-7 × 3-4 mm, red to purple, oblong-ellipsoid, pruinose, stylose with 0.4-0.8 mm long style.

Flowering & Fruiting

May - September.

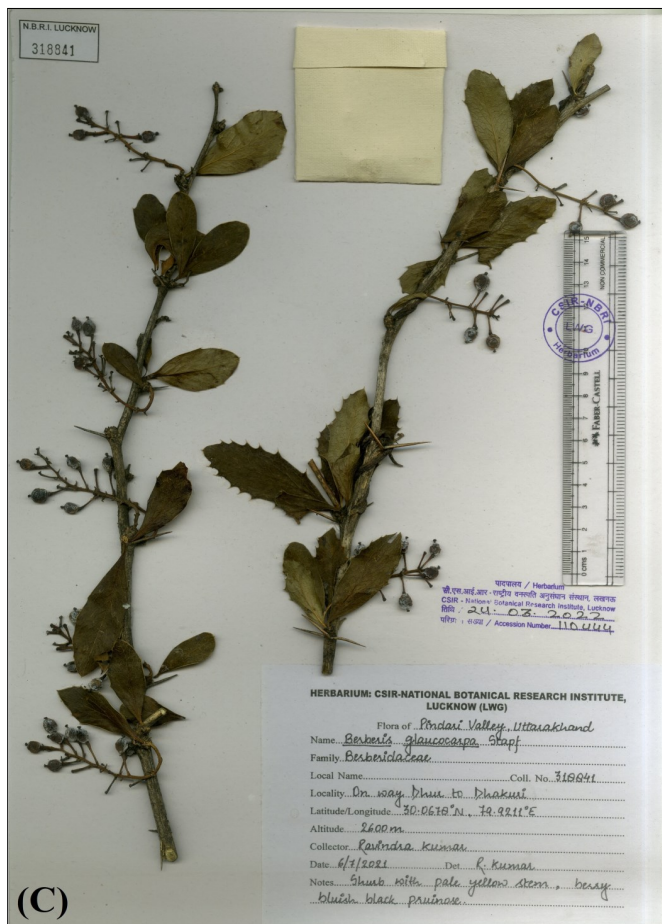
Distribution

INDIA [Western Himalaya: Himachal Pradesh & Uttarakhand] and NEPAL.

Representative specimens

Pindari Valley, Dwali to Phurkia, 30.177916N, 79.996117E, 2700 m, 01 June 2011, *T. Husain & Party* 261816 (LWG!).

Berberis glaucocarpa Stapf. in Bot. Mag. 101: t. 9102. 1926; Rao *et al.*, in Rheedea 8: 57. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 613. 2012; Pushalkar & S.K.Srivast., Fl. Uttarakhand 1: 449. 2018.(Fig. 2C).



Evergreen shrubs 3-4 m tall. Stems glabrous, pale yellow, terete, internodes 5-6 cm long; spines trifid, 1.5-2.3 cm long. Leaves 4-5 × 1.5-2.5 cm, obovate-elliptic, apex mucronate, margin spinulose. Inflorescence racemose, 15-25 flowered, 3-4 cm long. Flowers pale yellow. Berries 5-9 × 5-7 mm, oblong-globose, brownish black, pruinose-white, stylose with 1 mm long style.

Flowering & Fruiting

April - September.

Distribution

INDIA [Western Himalaya: Jammu & Kashmir to Uttarakhand] NEPAL and PAKISTAN.

Representative specimens

Uttarakhand, Kumaon, Pindari Valley, Phurkia-Dwali, 7A Rao 4608 (BSD!); Pindari Glacier, Khati, 30.113861N, 79.56557E, 2248 m, *Tariq Husain & Party* 261813 (LWG!); Pindari Valley, Dhur to Dhakuri, 30.0678 N, 79.9211E, 2600 m, 06 July 2021, *R. Kumar* 318842 (LWG!).

Berberis jaeschkeana C.K. Schneid. in Bull. Herb. Boissier, ser. 2, 5: 399. 1905; Duthie, Cat. Pl. Kumaon 8. 1906; Rao *et al.* in Rheedea 8: 118, f. 2. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8 (4): 614. 2012; Pusalkar & S.K.Srivast., Fl. Uttarakhand 1: 451. 2018.(Fig. 2D).

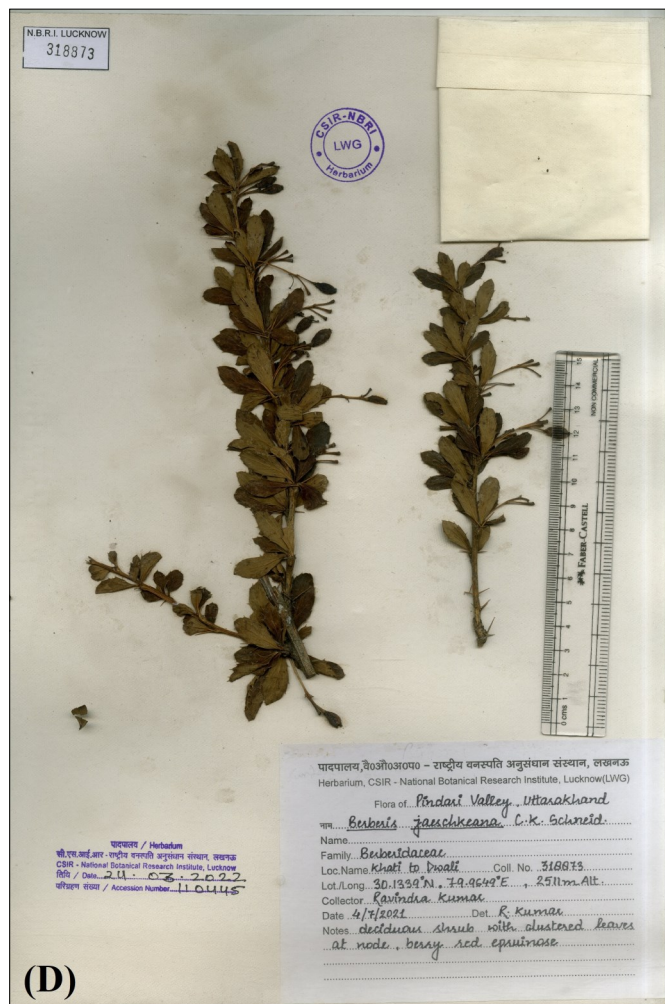


Fig. 2. A. *Berberis chitria*, **B.** *Berberis floribunda*, **C.** *Berberis glaucocarpa*, **D.** *Berberis jaeschkeana*.

Deciduous shrubs, 1-2 m tall. Stem glabrous, yellowish brown, succulate or angled, internodes 0.5-1.5 cm long; spines trifid, 0.5-1 cm long, central longer than laterals. Leaves 2-3 × 0.5-1 cm, sessile or subsessile, obovoid-oblong, often clustered at node, base attenuate, apex acute, margin dentate with minute spines. Inflorescence sub umbellate 4-8 flowered, 4 cm long. Flowers yellow, 8-12 mm in diameter. Berries 8-13 × 5-8 mm, oblong - ovoid, reddish-black, epruinose, stylose with 0.5 mm long style.

Flowering & Fruiting

April - October.

Distribution

INDIA [Western Himalaya: Jammu & Kashmir to Uttarakhand] CHINA, NEPAL and PAKISTAN.

Representative specimens

Uttarakhand, Pindari Valley, Khati to Dwali, 30.1339N, 79.9649E, 2511m, 04/07/2021, R. Kumar 318873 (LWG!).

Berberis kunawurensis Royle, Ill. Bot. Himal. Mts.: 64. 1834; Rao *et al.* in Rheedia 8: 131. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 615. 2012; Pusalkar & S.K. Srivast., Fl. Uttarakhand 1: 455. 2018.

Deciduous shrubs, 1-2 m tall. Stem puberulous, reddish, tuberculate, internodes up to 4 cm; spines trifid, 1.5 cm long. Leaves 1-3 × 0.5-1 cm, narrowly obovate-

lanceolate, base attenuate, margin dentate. Inflorescence paniculate 10-15 flowered. Flowers 5-8 mm in diameter, Bright yellow. Berries 6-7 × 3-5 mm, oblong-elliptic, orange red, epruinose, estylose. (Fig. 3A).



Flowering & Fruiting

March - September.

Distribution

INDIA [Western Himalaya: Jammu & Kashmir to Uttarakhand] and PAKISTAN.

Representative specimens

Pindari Valley, Khati to Dwali, 30.1882N, 79.9356E, 2188 m, 31 June 2011, T. Husain & Party 261804 (LWG!).

Berberis lycium Royle, Ill. Bot. Himal. Mts.: 64. 1834; Trans. Linn. Soc. Lond. 17: 94. 1834; Hook. f. & Thoms. in Hook. f., Fl. Brit. India 1: 110. 1872 *p.p.*; Osmaston, Forest Fl. Kumaon 20. 1927; Rao *et al.* in Rheedia 8: 98. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 70. 2007; U.L. Tiwari *et al.* in Check List 8(4): 613. 2012; Pusalkar & S.K. Srivast., Fl. Uttarakhand 1: 456. 2018.

Evergreen shrubs upto 2 m tall. Stem glabrous, grayish, internodes 2-3 cm long; spines trifid 1.5 cm long. Leaves 2-3 × 0.5-1 cm, oblanceolate, apex attenuate, margins entire rarely with 1-2 spines towards apex. Inflorescence axillary racemose 10-20 flowered. Flowers 6-8 mm in diameter, pale-yellow. Berries 7-9 × 4-6 mm, ovoid-ellipsoid, blue, pruinose, stylose with 1 mm long style.

Flowering & Fruiting

February-August.

Distribution

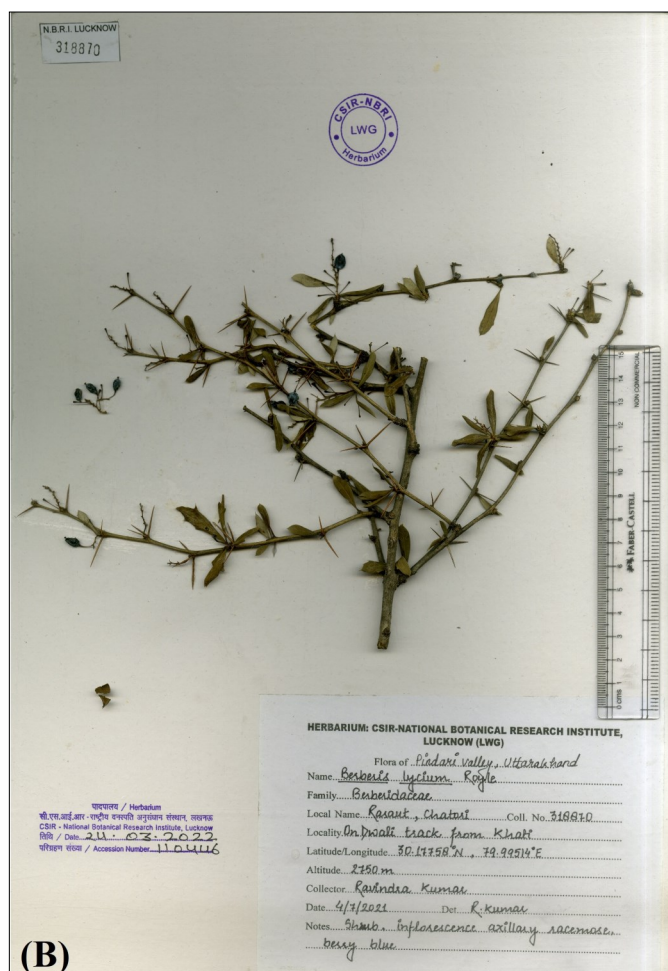
INDIA [Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Tamil Nadu, Uttarakhand and Uttar Pradesh], NEPAL and PAKISTAN.

IUCN Red List status

Least Concern (LC).

Representative specimens

Uttarakhand, Almora, Loharkhet to Dhakuri, 8000 ft, 18/05/1950, *DD Awasthi* 710 (LWG!); Pindari Valley, Khati to Dwali, 30.17758N, 79.99514E, 2750 m, 04/07/2021, *R.Kumar* 318870 (LWG!). (Fig. 3B).



Berberis pseudumbellata R. Parker in Bull. Misc. Inform. Kew 1921: 118.1921; Osmaston, Forest Fl. Kumaon 21. 1927; Rao *et al.* in Rheedia 8(2): 137, f. 9. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl 71. 2007; U.L. Tiwari *et al.* in Check List 8(4): 615. 2012; Pusalkar & S.K.Srivast., Fl. Uttarakhand 1: 460. 2018.

Deciduous shrubs, 2-3 m tall. Stems glabrous, brownish, sulcate, internodes 2 cm long; spines solitary, 0.8-1.5 cm long. Leaves 1.5-2.5 × 0.6-1.0 cm, oblong-obovate, apex obtuse or rounded, margins entire. Inflorescence sub-umbellate 5-10 flowered. Flowers 8-10 mm in diameter, yellow. Berries 5-10 × 4-8 mm, obovoid to ovoid, black or purple, pruinose, stylose with 0.5 mm style.

Flowering & Fruiting

May-October.

Distribution

INDIA [Western Himalaya: Jammu & Kashmir to Uttarakhand] and PAKISTAN.

Representative specimens

Uttarakhand, Pindari Valley, Khati to Dwali, 30.1339N, 79.9649, E 2188 m, 27/09/2021, *D. Parsad & S.Sharma* 318871 (LWG!). (Fig. 3C).



Berberis umbellata Wall. ex G. Don, Gen. Hist. 1: 116. 1831; Hook.f. & Thoms. in Hook. f., Fl. Brit. India 1: 110. 1872p.p.; Osmaston, Forest Fl. Kumaon 19. 1927; Rao *et al.* in Rheedia 8(1): 29, f. 8. 1998; Uniyal *et al.*, Flow. Pl. Uttarakhand Checkl. 71. 2007; U.L. Tiwari *et al.* in Check List 8(4): 613. 2012; Pusalkar & S.K.Srivast., Fl. Uttarakhand 1: 462. 2018.

Evergreen shrubs, 1.5 m tall. Stems glabrous, redish, sulcate, internode 3 cm; spines trifid, 5-10 mm long. Leaves 1.5-3.5 × 0.5-1.5 cm, obovate or oblanceolate, base cuneate, apex acute, margin entire. Inflorescence umbellate 3-10 flowered. Flowers yellow. Berries 8-10 × 4-5 mm, oblong-ellipsoid, red, pruinose, estylose.

Flowering & Fruiting

May-September.

Distribution

INDIA [Western Himalaya: Uttarakhand] BHUTAN and NEPAL.

Representative specimens

Pindari Valley, Phurkia, 30.2136N, 79.9778E 3224 m, 02/06/2011, Tariq Husain & Party 261850 (LWG!). (Fig. 3D).

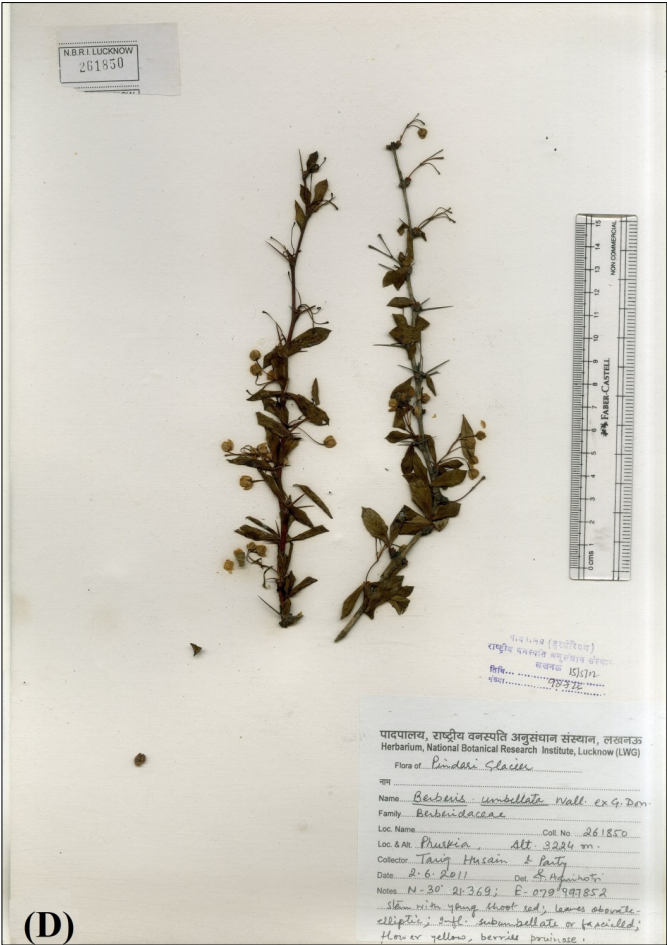


Fig. 3. A. *Berberis kunawurensis*, B. *Berberis lycium*, C. *Berberis pseudumbellata*, D. *Berberis umbellata*.



Fig. 4. Field Photographs A. *Berberis aristata*, B. *Berberis asiatica*, C. *Berberis canadensis*, D. *Berberis chitria*, E. *Berberis glaucocarpa* F. *Berberis jaeschkeana*, G. *Berberis kunawurensis*, H. *Berberis lycium*, I. *Berberis umbellata*.

Conclusion

The present study reports the occurrence of 12 species of *Berberis* from Pindari Valley (Fig. 5), which is a noteworthy

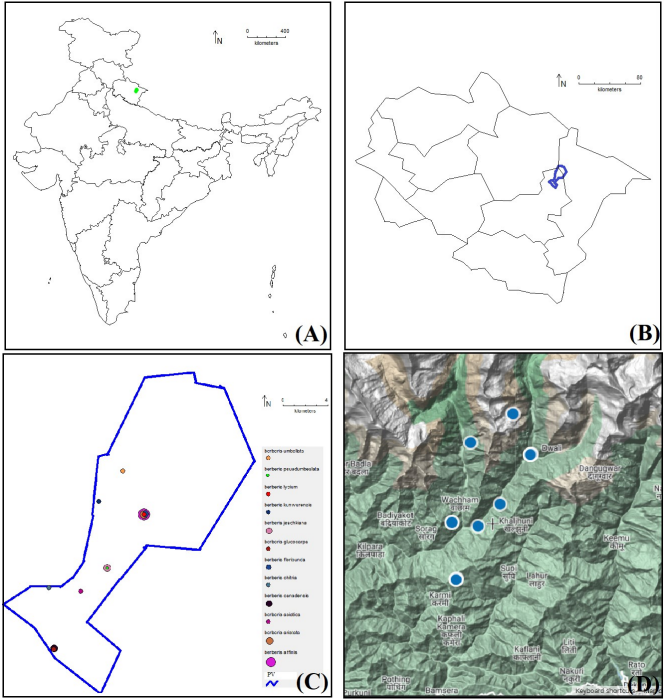


Fig. 5. A. Map of India, B. Uttarakhand, C. Pindari Valley, D. Pindari Valley, terrain view.

contribution to the floristic diversity of Valley. In Uttarakhand, Pindari Valley possesses maximum diversity of the genus *Berberis*, followed by Gangotri National Park (6 species) (23) and Kedarnath Wildlife Sanctuary (6 species) (24), Sundardunga Valley (5 species) (1) and Valley of Flowers National Park (3 species) (25) (Fig. 6). These species are mainly confined to an elevational range of 2200-3200 m.

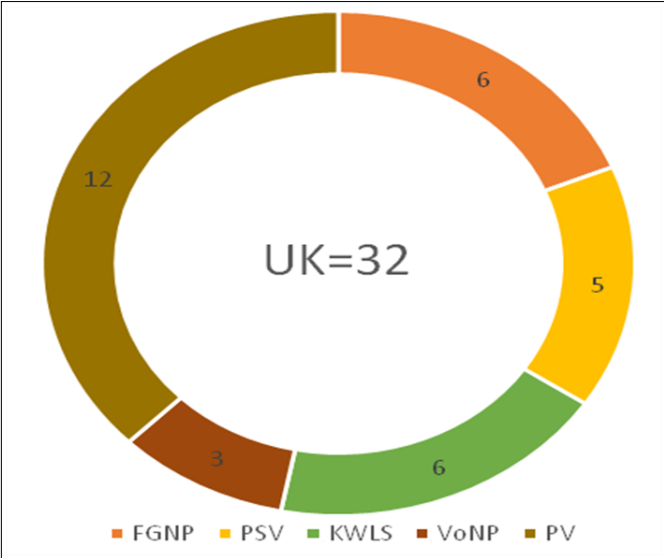


Fig. 6. Documented number of species of *Berberis* in different Valley and protected area of Uttarakhand. (FGNP – Flora of Gangotri National Park, PSV – Phytodiversity of Sunderdunga Valley, KWLS – Kedarnath Wildlife Sanctuary, VoNP – Valley of Flower National Park & PV – Pindari Valley).

Moreover, *B. affinis*, an endemic species of Uttarakhand is also found in Pindari Valley and 2 species namely, *B. aristata* and *B. lycium* are included in RED LIST of IUCN under Least Concern (LC) category.

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Authors contributions

RK searched all the necessary material and prepared the first draft of the manuscript. PD and KY helped in refining the manuscript. PA supervised the whole work, included her suggestions, modified the manuscript and submitted the manuscript for publication. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

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