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Biodiversity Boost: *Polygonatum punctatum* Royle ex Kunth, a new distribution record from the Western Himalaya, India

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ABSTRACT

High-altitude wetlands in the West Himalaya, fed by glaciers and snow, play a crucial role in sustaining downstream landscapes through vital ecosystem services. Mid-elevation oak forests, particularly *Quercus floribunda* (Tilonj oak), are essential for carbon sequestration, soil stabilization, water filtration, and biodiversity support. The study focuses on Devriya Tal, a high-altitude lake surrounded by Tilonj oak forests, which recently revealed the range extension of a new plant species, *Polygonatum punctatum*. The wetland faces serious threats from uncontrolled tourism, waste mismanagement, conflicting economic needs, insufficient conservation efforts, climate change, and overuse of oak forests by local inhabitants. The recommendations have been proposed through adaptive management and sustainable forest practices to preserve habitats, support sustainable livelihoods, and improve ecosystem resilience.

Keywords: Devriya Tal, Kedarnath Wildlife Sanctuary, *Polygonatum*, *Quercus floribunda*, Uttarakhand

1. INTRODUCTION

Many wetlands in the west Himalaya are located in high altitudes, often fed by glaciers or snow from the surrounding mountains. At the same time, mid-Himalayan lakes receive water from the surrounding catchment basin, comprised of dense forest on the hill slopes and springs and contribute significantly to the sustenance of downstream landscapes and communities by providing ecosystem services (RCW, 2018). Forests contribute to regulating river flows and maintaining various extremes of weather and climate, functions categorized under ecosystem services as described by the Millennium Ecosystem Assessment (MEA, 2005). At the mid-elevation region, the ecosystem services are primarily provided by different oak forests, viz. *Quercus leucotrichophora, Q. glauca, Q. floribunda,* and *Q. lanata* in the western Himalaya. Among these forests, *Q. floribunda* exhibits a multi-layered structure with a dense canopy, an understory of shrubs and smaller trees, and a forest floor enriched by leaf litter and decomposing organic matter. This structure facilitates complex ecological interactions and processes (Rawat and Adhikari, 1993).

According to Rawat and Singh (1988), the *Q. floribunda* forests are pivotal in

carbon sequestration, mitigating climate change by reducing atmospheric CO_2 levels. Their root systems stabilize soil, preventing erosion and landslides, particularly in hilly regions. These forests act as natural filters for rainwater, reducing sediment and pollutants to preserve the quality of streams and rivers. The diverse habitats within *Q. floribunda* forests promote biodiversity, protect endangered species, and help sustain ecological balance. *Q. floribunda* forests play a vital role in nature's cycle by helping plants pollinate and spread their seeds, ensuring healthy plant growth and stable communities (Singh and Singh, 1992). Beyond their ecological value, these forests are deeply connected to local culture and provide spaces for recreation and relaxation, enriching the lives of nearby communities while promoting conservation. They also influence weather patterns, helping to regulate temperatures and maintain the regional climate. Recognizing these contributions shows just how essential it is to protect *Q. floribunda* forests for the long-term health and balance of Himalayan ecosystems.

2. MATERIAL AND METHODS

Study area

Among various mid-altitude lakes, used by migrating birds as a nesting place or as stopover corridors, Devriya Tal (30°31′19" N and 79°07′35" E at an altitude 2405m asl) is located 2.5 km above village Sari on Chopta-Ukhimath road in Rudraprayag district of Uttarakhand state, is one of them lies in Kedarnath Wildlife Sanctuary with its religious values. Devriya Tal is surrounded naturally by *Quercus floribunda* Lindl. ex A.Camus forest, commonly known as Tilonj (in Kumaon region) and Moru (in Garhwal region). It is native to Himalayan region and thrives at high elevations between 2300-2700m asl (Plate I-A). *Q. floribunda* supports rich biodiversity, providing habitat for a variety of flora and fauna, including birds, insects, fungi, and other plants.

The vegetation in and around Devriya Tal represents upper temperate forest with a predominance of *Cedrus deodara* Roxb. G.Don, *Myrica esculenta* Buch.-Ham. ex D.Don, *Quercus leucotrichophora* A. Camus in shady moist places; *Juglans regia* L., *Acer caesium* Wall. Ex Brandis and *Aesculus indica* Wall. Ex Cambess. Hook along water channels or exposed sites; while *Lyonia ovalifolia* Wall Drude and *Rhododendron arboreum* Sm. forms the under-canopy. The shrubs like *Berberis aristata* DC., *Berberis asiatica* Roxb. ex DC, *Berberis lyceum* Royle., *Cotoneaster microphyllus* Wall. ex. Lindl., *Pyracantha crenulata* D. Don M. Roem., *Rosa moschata* Herrm., *Daphne papyracea* Wall. Ex G.Don and *Sarcococca saligna* D.Don Mull.Arg. are scattered all over the forest.

Field observation:

While walking alongside the Devriya Tal, a group of 20-30 individuals of the conspicuous plant bearing light purple-white flowers growing on *Quercus leuchotrichophora, Q. floribunda* (Plate I-B), *Rhododendron arboreum* (Plate I-C) and *Lyonia ovalifolia* (Plate I-D) trees, were seen during May in 2024 and April 2025. The plant specimens were collected for further examination at the Herbarium of Wildlife Institute of India 'WII', Dehradun.

Examination:

Using various floras available in the herbarium of WII, Dehradun and through other floras available online, the specimen of the plant was examined. The specimen turns out to be the Genus *Polygonatum* Mill. and further taxonomic investigations revealed that the species is *Polygonatum punctatum* Royle ex Kunth. The herbarium sheet was prepared and deposited in 'WII' herbarium.

3. RESULTS

The genus *Polygonatum* Mill. (Family Asparagaceae) comprises 71 species and four varieties, distributed across temperate regions of the Northern Hemisphere, includes China, Japan, Korea, India, Russia, Europe, and North America (Zhao et al., 2018; Ai, 2014; TPL, 2017; Gates, 1917). Most species of *Polygonatum* thrive in moist, shaded environments, often within forests or underbrush characterized by rich, fertile soils. Of the total 71species, 37 species and one variety have been reported for their medicinal value, with the rhizome being the most utilized part (Zhao et al., 2018). *Polygonatum punctatum*, also known as Solomon's seal, is used as an antibiotic, anti-inflammatory, and anti-hyperalgesic, while Polygodial, the fungitoxic component (Almeida Alves et al., 2001), attributed to folk medicine in Brazil and used in traditional Vietnamese medicine for kidney issues, joint pain and treating other ailments (Ha et al., 2023; Tham et al., 2024).

The plant: *Polygonatum punctatum* Royle ex Kunth (Plate II-A)

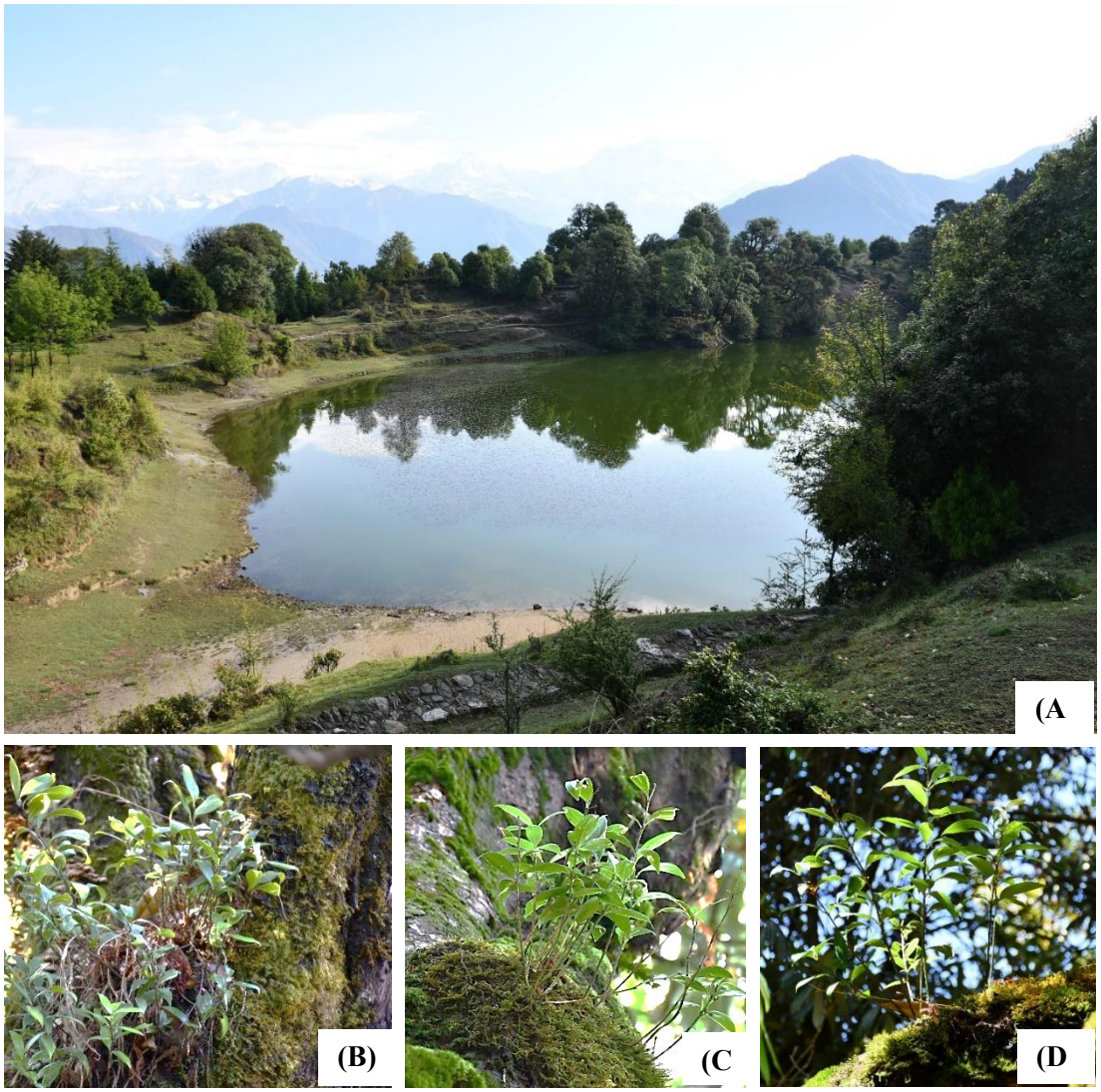

Plate I Devriya Tal (Lake) surrounded by cool temperate forest (*Quercus* spp., *Rhododendron arboreum, Lyonia ovalifolia, Pyrus pashia*) at 2400 m asl (A), *Polygonatum punctatum* growing on *Q. floribunda* (B), *Rhododendron arboreum* (C) and *Lyonia ovalifolia* (D) trees adjacent to Devriya Tal.

Synonym: *Disporopsis mairei* H. Leveille; *Polygonatum anomalum* Hua; *P. marmoratum* H. Leveille; *P. mengtzense* F. T. Wang & T. Tang; *P. parcefolium* F. T. Wang & T. Tang; *P. sinomairei* F. T. Wang & T. Tang.

Nativity: The species is distributed from Eastern Nepal to China (Guangxi, Guizhou, Hainan,? S Shaanxi (Qin Ling), Sichuan, Xizang, Yunnan), Myanmar, Thailand, Vietnam and India (Sikkim, NE India) as per the Plants of The World online (POWO, 1850).

Habit: It is a rhizomatous geophyte or epiphyte that generally grows in the temperate region (Plate II-D&E)

Habitat: Grow on the branches of *Quercus floribunda, Rhododendron arboreum,* and *Lyonia ovalifolia* on the shady side of the lake.

Uses: Young shoots are used as a vegetable in Nepal (Khakurel *et al.* 2021), decoction of subterranean parts/stem against respiratory system, disorders, and dizziness; and as tonic in Yunnam, China (Weckerle *et al.* 2009). The roots are cooked with pork for nourishing in Guizhou, China (Wang *et al.* 2021) and rhizome to treat arthralgia in Thailand and Vietnam (Panyadee *et al.* 2024).

New record: India: West Himalaya: Uttarakhand: Rudraprayag, Devriya Tal (30°31′9" N and 79°07′35" E at an altitude 2405m asl), Collected on 7 May, 2024 and 17 May, 2025 (WII/BSA/2024-2025/1, 2 & 3).

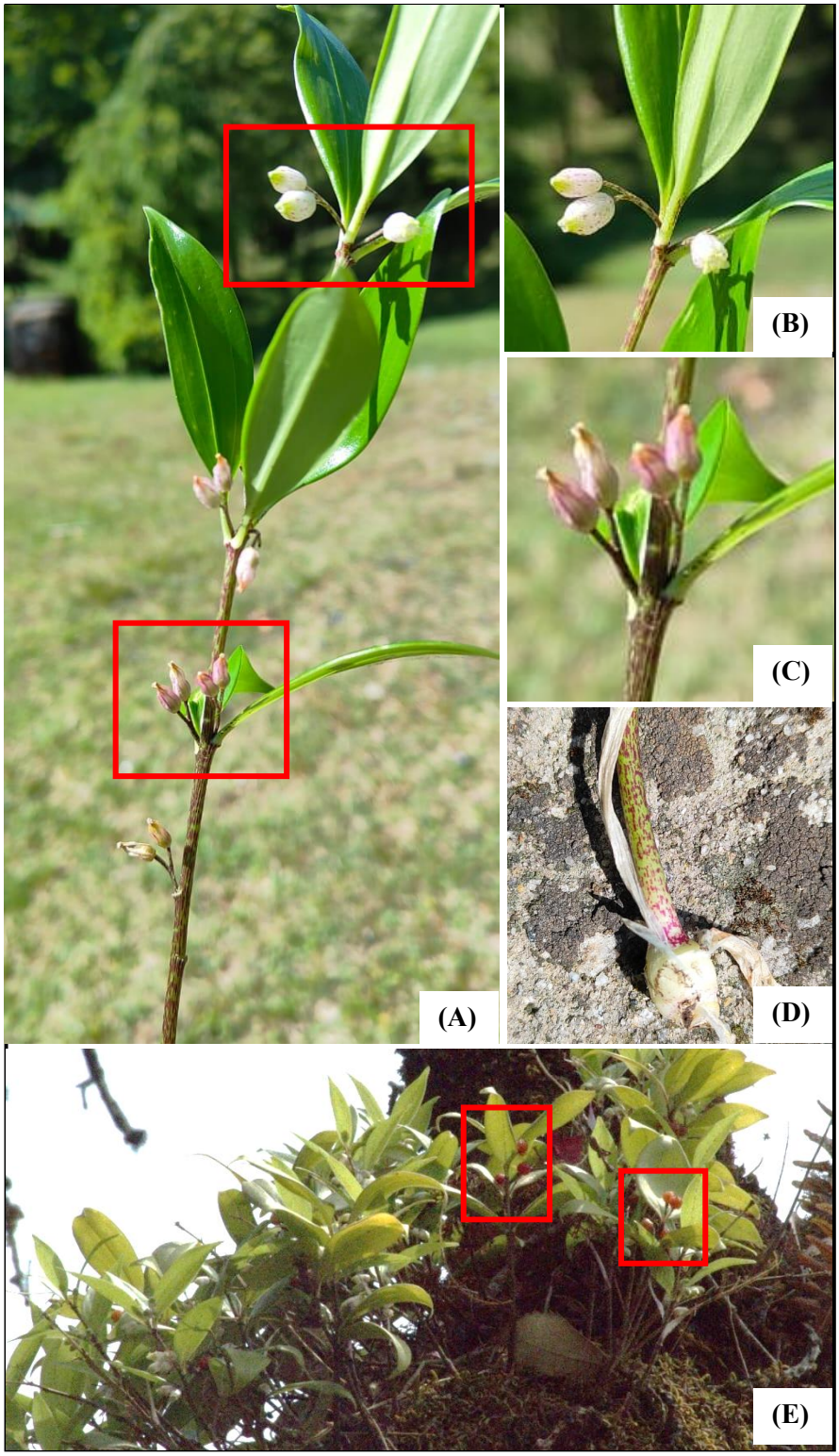

Plate II An individual of *Polygonatum punctatum* with flowers (A), close-up of flowers shown in inset (B & C) and main stem with dots and rhizome (D), while orange-yellowish berries in the inset (E).

Description: Rhizome ± moniliform, 1-1.5 cm thick, with dense, fleshy roots (Plate II-D). Stem arching, usually spotted with lilac, (10-) 30-70 cm, sometimes papillose distally. Leaves alternate or occasionally also sub-opposite, thick, glossy, evergreen; petiole short; dotted midrib, leaf blade ± shiny, ovate to lanceolate, rarely slightly falcate, 6-14×1.5-5 cm, usually with distinct cross veins, apex ± acuminate and obtuse tipped. Inflorescences racemose, 2-6(-8)-flowered (Plate II-A); peduncle 5-12 mm; bracts caducous or absent. Flowers pendulous to erect are borne in clusters at each leaf axil in late spring to summer (Plate II-B&C); pedicel 2-10 mm. Perianth white, sometimes greenish spotted with lilac, ± urceolate, 7-9(-11) mm; lobes 1.5-2 mm. Filaments filiform, 0.5-1 mm, smooth to scabrous; anthers 1.5-2 mm. Ovary 2-2.5(-4) mm. Style 1.5-2.5 mm; stigma slightly dilated. Berries red, ca. 7 mm in dia., 8-10-seeded (Plate II-E). Flower light purple-white in April-June, Fruit September-November (FOC, 2014).

4. DISCUSSION

The *Polygonatum* species found in India are distinguishable based on rhizome, stem, leaf arrangement (with some species having whorled or hooked leaves), flower (typically bell-shaped and vary in color, which helps distinguish the species), fruit (changing colors and shapes of the berries, which aids in species differentiation) and habitat characteristics (most species prefer moist, shaded environments, though there are specific preferences like montane forests or forest edges) are compared in Table 1.

Table 1. Distribution, habitat, and plant part characteristics of different species of *Polygonatum* reported from India.

Species	Distribution	Habitat	Parts characteristics				
			Rhizome	Stem	Leaf	Inflorescence	Fruit
Polygonatum multiflorum (L.) All. (Common Solomon's Seal)	Europe, Himalaya, Western Ghats	Shady, forest edges and moist woodlands between 700-2100m asl	Rhizomes terete 5-9 mm broad, profusely covered by roots	Stems 15-90 cm, terete, glabrous	Leaves alternate, sessile or shortly petiolate 5-15 × 2-7.5 cm, elliptic, oblong or ovate, glabrous, entire, tip subacute to obtuse	Greenish-white, bell-shaped, in pairs or clusters (2-3 flowered), peduncle 10-12 mm, glabrous, pedicel 6-7 mm. Perianth 14-15 mm, filaments sparsely puberulent	Dark bluish-black berries. ca. 7-9 mm in diameter
Polygonatum verticillatum (L.) All. (Whorled Solomon's Seal)	Europe, Russia, SE Asia, Himalaya (Afghanistan, Bhutan, India, Nepal, Pakistan)	Montane forests, shaded areas between 2100-3300 m asl	Rhizome usually shortly branched, tuberous terete, very rarely moniliform (0.7-1.5 cm thick)	Stem erect 30-90 cm, angled, glabrous	Leaves in whorls of 3, occasionally alternate near the base of the stem, sometimes opposite near apex of the stem, subsessile, oblong-lanceolate to linear, 6-10 × 0.5-3 cm, apex acute to acuminate, not cirrose	Small, greenish or white, in clusters 1-2 (-4) flowered; peduncle 1-2 cm, bract <1 mm, or absent, pedicel 2.5-4.5 mm; perianth 8-9 mm, pale yellow, contracted in the middle, teeth inside and at the tip hairy. Stamens epipetalous, filaments 0.5-1 (-2) m, papillose. Ovary c. 3 mm, style 2.5-3 mm	Red berries 6-9 mm in diam., 6-12 seeded
Polygonatum cirrhifolium (Wall.) Royle (Hooked-leaf Solomon's Seal)	Mongol (Korea, Far East Russia), Eastern Himalaya (Bhutan, India, Nepal)	Forested slopes, shaded, moist areas Forests, thickets, grassy slopes between 2000-4000 m asl	Rhizome moniliform or tuberous terete, 1-2 cm thick	Stem erect or scandent, 30-90 cm, glabrous	Leaves alternate, hooked or curled in whorls of 3-6, rarely also a few alternate in the proximal part of the stem, sessile, narrowly linear to linear-lanceolate, very rarely oblong-lanceolate, 4-9(-12) cm × 2-8(-15) mm, apex usually cirrose or curved margin	2-3 bell-shaped flowered; peduncle 3-10 mm; bracts 1-2 mm, scarious, veinless, or bract absent. Flowers pendulous, pedicel 3-8 mm. Perianth white-greenish or pale purple, subcylindric, slightly constricted in the middle, 8-11 mm; lobes ca. 2 mm.	Berries red or purple-red, 8-9 mm in diam., 4-9-seeded

						Filaments 0.6-0.8 mm long, papillose; anthers 2-2.5 mm. Ovary ca. 2.5 mm. Style ca. 2 mm	
Polygonatum hookeri Baker (Hooker's Solomon's Seal)	China, NE Himalaya	Moist, shaded forests and undergrowth between 1500-3500 m asl	Rhizome terete, 3-7 mm thick, usually with slightly swollen annual knots; annual elongation (distance between knots) 2-3.5 cm	Stem erect, <10 cm, glabrous	Leaves opposite >10, crowded, proximal leaves alternate, sessile, linear, obtuse, glaucous beneath	Flowers axillary, erect, solitary, pedicel 4-7 mm. Perianth purple or pink, cylindric-funnelform, 1.5-2(-2.5) cm; tube 3-4 mm wide; lobes 6-10 mm. Filaments very short, ca. 0.5 mm, anthers ca. 2 mm, Ovary 2-3 mm. Style 1.5-2 mm	Berries red, 7-8 mm in diam., 5-7 seeded
Polygonatum officinale All. (Common Solomon's Seal)	China, Japan, Korea, Mongolia, Russia, Europe, Himalaya	Woodlands, forest edges, shaded areas between 500-3000 m asl	Rhizome terete, 5-14 mm thick	Stem arching, 20-50 (-100) cm, glabrous, angled	Leaves 7-12, alternate; petiole short; dotted midrib, leaf blade abaxially glaucous, elliptic to ovate-oblong, 5-12(-20) × 3-6(-8) cm, often smooth, sometimes papillose-scabrous on veins, apex acuminate and obtuse tipped	1-4(-8) flowered; peduncle usually 1-1.5 cm; bracts small or absent. Flowers pendulous, bell-shaped, pedicel 5-10(-20) mm. Perianth yellowish green to white, cylindric to campanulate-cylindric, 1.3-2(-2.5) cm; lobes ca. 3 mm. Filaments filiform, smooth or verruculose; anthers ca. 4 mm, Ovary 3-4 mm. Style 1-1.4 cm	Berries blue-black, 7-10(-12) mm in diam., 7-9 seeded
Polygonatum punctatum Royle ex Kunth (Spotted Solomon's Seal)	East Asia (China, Japan, Myanmar, Thailand, Vietnam), Himalaya (Bhutan, NE India, Nepal)	Forest, on rocks or trees in forests between 1100-2700 m asl	Rhizome ± moniliform, 1-1.5 cm thick, with dense, fleshy roots	Stem arching, usually spotted with lilac, (10-)30-70 cm, sometimes papillose distally	Leaves alternate or occasionally also subopposite; thick, glossy, evergreen and spotted, short petiole; leaf blade ± shiny, ovate to lanceolate, rarely slightly falcate, 6-14 × 1.5-5 cm, usually with distinct cross veins, apex ± acuminate and obtuse tipped	Racemose, 2-6(-8)-flowered; peduncle 5-12 mm; bracts caducous or absent. Flowers pendulous to erect; pedicel 2-10 mm. Perianth white, sometimes greenish spotted with lilac, ± urceolate, 7-9(-11) mm; lobes 1.5-2 mm. Filaments filiform, 0.5-1 mm, smooth to scabrous; anthers 1.5-2 mm. Ovary 2-2.5(-4) mm. Style 1.5-2.5 mm; stigma slightly dilated	Dark red/orange colored berries, ca. 7 mm in diam., 8-10 seeded

5. CONCLUSION

The high-altitude wetlands in the West Himalaya are under serious threat. The unregulated tourism, inadequate waste management, and conflicting economic interests of local communities are some of the issues which are adversely affecting these fragile ecosystems. Additionally, limited conservation efforts, rising temperatures, and overexploitation of oak forests are contributing to the degradation of adjacent habitats. Together, these challenges are threatening the survival of unique high-altitude lakes and the newly discovered species that inhabit them.

Regulating visitor numbers and promoting eco-friendly practices are vital for fostering sustainable tourism and protecting these high-altitude lakes. Effective waste management and recycling systems, coupled with targeted educational initiatives, should be implemented to promote environmental stewardship. Ensuring the preservation of indigenous traditions and collaboration with local communities to incorporate their traditional knowledge into conservation efforts. Strengthen community-based conservation efforts by promoting participation and awareness among local youth and reducing dependency on fuel wood and fodder from the surroundings of the lake. Adopt sustainable strategies for managing the lake's surrounding vegetation, such as planting native species, to conserve and enhance its natural assets.

Authors contributions

BSA examined the specimens, drafted the manuscript, while Dr. Navendu Page and Shivam confirmed the identity of the specimen.

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Conflict of Interest

The authors declare that they have no conflicts of interests, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Informed consent

Not applicable.

Ethical approval & declaration

The approval of the field visit was obtained (Letter. No. 2944/5-6 dated 06/05/2025) from the office of CWLW, Uttarakhand, Dehradun. The ethical guidelines for plants & plant materials are followed in the study for species observation, identification & experimentation.

Data and materials availability

All data associated with this study are present in the paper.

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