



Research Article



Article History

Received: 16.04.2026
 Revised: 25.05.2026
 Accepted: 03.06.2026
 Online
 Version: 1

Additional Information

Peer review: The publisher expresses gratitude to the anonymous reviewers and sectional editors for their invaluable contributions during the peer review process.

Reprints and Permissions Information is available at:

https://phytotalks.com/journal/index.php/PT/open_access_policy

Publisher's note: Regarding jurisdictional claims in published maps and institutional affiliations, PhytoTalks maintains its objectivity.

Copyright: This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which grants anyone worldwide the freedom to share, copy, and adapt the licensed work for any purpose—even commercially—provided they give appropriate credit to the original creator.

©The authors retain copyright of their work. The journal allows the author(s) to hold the copyright and to retain publishing rights without restrictions.

Cite this article: Gyeltshen, Ngawang T, Tiger Sangay T, Phuentsho, Lam N, Rinchen D, Namgay S. Additions to the Flora of Bhutan: New National Records and Range Extensions of Primulaceae and Orchidaceae from Central and Eastern Bhutan. *PhytoTalks*. 2026; 3(2): 882-891.

Additions to the Flora of Bhutan: New National Records and Range Extensions of Primulaceae and Orchidaceae from Central and Eastern Bhutan

Gyeltshen^{1*}, Ngawang Tenzin², Tiger Sangay¹, Sangay Tshewang³, Phuentsho⁴, Lam Norbu¹, Rinchen Dorji⁵, Namgay Shacha¹

¹Ugyen Wangchuck Institute for Forestry Research and Training, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Lamai Goempa, 34001, Bumthang, Bhutan

²Monggar Divisional Forest Office, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Lhuentse, Bhutan

³Samdrup Jongkhar Divisional Forest Office, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Samdrup Jongkhar, Bhutan

⁴National Biodiversity Centre, Ministry of Agriculture and Livestock, Thimphu, Bhutan

⁵Nature Conservation Division, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Thimphu, Bhutan

*Corresponding Author's Email: omgyaelo@gmail.com; gyeltshen@uwice.gov.bt

Abstract

The Sino-Himalayan region is a speciation and diversity hotspot for montane flora, yet many remote alpine and temperate ecosystems remain under-explored. The current study adds significantly to the families Primulaceae and Orchidaceae to improve our knowledge of the floristic richness of Bhutan and its wider biogeographic relationships with neighboring floristic provinces. Floristic surveys were done along temperate and high-altitude gradients in Lhuentse, Trashiyangtse and central Bhutan from 2020 to 2026. The collected materials were morphologically analyzed in detail. Physical specimens were preserved and deposited at the National Herbarium of Bhutan (THIM). For remote or protected populations, virtual validation was conducted using non-invasive macro-photography against digitized global types and national biodiversity datasets. Spatial analysis and preliminary conservation assessments were performed using ArcGIS Pro and GeoCAT following IUCN guidelines. *Primula dumicola* W.W.Sm. (Primulaceae) and *Habenaria lucida* Wall. ex Lindl. (Orchidaceae) are reported as new national records for Bhutan. *Habenaria lucida* adds to the national orchid tally, taking it to 507 species. The morphological study of *P. dumicola* population in Lhuentse reveals homostyly, a specialized reproductive system for self-pollination. In addition, we report a significant global westward range extension of *Liparis sootenzanensis* Fukuy. from Southeast Asia and its subsequent eastward distribution record within the country. The alpine stoloniferous *Primula flagellaris* W.W. Sm. is also confirmed to have a major eastward range extension. These findings effectively bridge critical distribution gaps between the Eastern Himalayas and the Hengduan Mountains, reinforcing a convincing botanical affinity between the flora of Bhutan and southwest China.

Keywords: Biodiversity; Conservation; Lhuentse; New records; Sino-Himalayan.

Introduction

The Sino-Himalayan region stands as a primary center of diversity and speciation for the genus *Primula* L. (Primulaceae), harboring over 300 species within its complex mountain systems^{1,2}. Within this high-altitude landscape, Bhutan serves as a vital biogeographical corridor, facilitating evolutionary radiation and species migration between the Tibetan Plateau and the Southeast Asian highlands³. Traditionally, the Western Himalayas and the Hengduan Mountains of Southwest China have been treated as distinct floristic provinces; however, Ward⁴ and others have suggested that the rugged corridors of north-eastern Bhutan function as a critical bridge linking these regions. This connectivity contributes to the high levels of species richness and endemism characteristic of the Sino-Himalayan flora^{5, 6}.



Despite Bhutan's documented botanical richness, many remote ecosystems ranging from high-altitude alpine meadows to warm broadleaved forests remain under-explored. Recent floristic surveys conducted between 2020 and 2026 in the Lhuentse and Trashiyangtse districts, supplemented by opportunistic observations in Jigme Singye Wangchuck National Park (JSWNP), have yielded significant findings within Biological Corridor 7 and the Wangchuck Centennial National Park. Parallel to these discoveries, Bhutan's orchid flora continues to expand, growing from the 369 species recorded by Pearce and Cribb to a recent tally of 506 species following the description of *Zeuxine drukyulensis*^{7,8,9}. This paper reports significant additions to the Primulaceae and Orchidaceae families in Bhutan, including two new national records and two major range extensions. We document *Primula dumicola* W.W. Sm. (section *Obconicolisteri*) and *Habenaria lucida* Wall. ex Lindl. as new national records, the latter increases the national orchid tally to 507 species. Additionally, we identify significant range extensions for *Primula flagellaris* W.W. Sm. and *Liparis sootenzanensis* Fukuy. The latter is a major westward extension into the world from SE Asia. Integrating these records with recent phylogenomic data, the study stresses the specialized adaptations such as homostyly and stoloniferous habits and the importance of biological corridors in Bhutan in bridging distribution gaps in the Sino-Himalayan flora.

Materials and Methods

1. Study area and field sampling

Floristic surveys were conducted from 2020 to 2026 along temperate and high-altitude gradients in the Lhuentse and Trashiyangtse districts of North-Eastern Bhutan, supplemented with opportunistic records from Jigme Singye Wangchuck National Park (JSWNP) in Central Bhutan.

Research sites consisted of moist meadows, temperate forest understory and *Pinus roxburghii* (Chir pine) ecosystem. The major study sites were Biological Corridor 7 (BC7) near Zarthang Goenpa (2500 m a.s.l.), eastern parts of Wangchuck Centennial National Park (WCNP), Rinchen Bumpa, Kurtoe (3026 m a.s.l.) and broadleaved forest complexes within JSWNP. Fieldwork was timed to coincide with peak flowering windows across the months of March–August.

Morphological Studies & Photography

The specimens collected were based on fresh material for morphological studies. Vegetative and floral organs were measured with standard metric scales. Diagnostic characters were recorded using high-resolution digital photography (Canon EOS 250D, 18–55 mm lens), especially the complex structures of the orchid labellum and spur, *Primula* leaf architecture and stylar conditions (homostyly vs. heterostyly).

In cases where physical collection was not possible (e.g. the JSWNP occurrence), multiple macro-photographic angles of the floral and vegetative features were taken to allow remote taxonomic verification.

2. Specimen preparation and identification

Physical specimens of *Primula dumicola* (Lhuentse population) and the recorded Orchidaceae (*Habenaria lucida* and *Liparis sootenzanensis*) were collected, pressed with the standard herbarium techniques and deposited at the National Herbarium of Bhutan (THIM). Non-invasive photographic vouchers were preferred for *Primula flagellaris* and the *P. dumicola* record from JSWNP because of localized population sizes and logistical constraints of remote high-altitude or protected habitats. These records were authentically examined through a four-stage virtual verification:

1. **Direct Comparative Analysis:** Morphological traits from *in situ* photographs were compared against digitized type specimens held at the Royal Botanic Garden Edinburgh (2026) (*P. flagellaris* Barcode: E01404657; *P. dumicola* Barcode: E00272332) available at <https://www.rbge.org.uk/collections/herbarium/>
2. **Literature-Based Validation:** Morphological traits, specifically the presence of node-rooting stolons, were cross-referenced with the *Flora of Bhutan*.⁵
3. **Expert Community Consultation:** Field observations were validated against documentation from the *Primula* World project¹⁰, which addresses the specific taxonomic complexities of stoloniferous *Primula* in the Bhutanese Black Mountains.
4. **National Record Integration:** The observation was cross-referenced with established datasets on the Bhutan Biodiversity Portal (NBC, 2026) (<https://biodiversity.bt/species/show/9298>), ensuring consistency with the known

phenological and altitudinal range of the species within the country. The digital voucher has been deposited in the National Biodiversity Portal (NBC) (<https://biodiversity.bt/observation/show/940002>).

Species identification followed a critical review of the *Flora of Bhutan*⁵ and *The Orchids of Bhutan*⁷. For *Primula* taxa, morphological characters were evaluated against the monograph by Richards¹ and the *Flora of China*². Identifications were validated by cross-referencing digitized specimens from the Royal Botanic Garden Edinburgh (E), Royal Botanic Gardens, Kew, and the Global Biodiversity Information Facility (GBIF)^{11,12,13}. Expert verification for range extensions was provided by specialist networks¹⁰.

3. Mapping and conservation assessment

Distribution maps were generated in ArcGIS Pro 3.6 using *in situ* coordinates (Garmin eTrex 30), global records from GBIF¹³, and spatial data for *Liparis sootenzanensis* from Gyeltshen et al.⁹. All data were projected in the WGS 1984 coordinate system. Preliminary conservation statuses were evaluated following IUCN categories¹⁴. Extent of Occurrence (EOO) and Area of Occupancy (AOO) were calculated via GeoCAT¹⁵, restricted to records coded as 'Extant' and 'Native' or 'Reintroduced'. AOO was scaled to the mandatory 2 × 2 km grid, and EOO was adjusted to equal AOO where the calculated EOO was smaller, ensuring consistency with IUCN standards¹⁶.

Results

3.1. Primulaceae

3.1.1. *Primula dumicola* W.W. Sm., Notes from the Royal Botanic Garden, Edinburgh 9: 169 (1916). (Fig. 1)

Type: CHINA. Yunnan: *Forrest 2165* (holotype: E!, barcode E00272332; isotype: K!)¹⁷.

Section: *Obconicolisteri* Balf.f.

Description: Perennial herb, small and delicate; rhizome short, slender, woody. Leaves in a lax rosette; petioles 1.5–4 cm, sparsely to densely pilose; lamina broadly ovate to elliptic-ovate, 1.5–4.5 × 1–3 cm; margin irregularly dentate to lobulate; base cuneate to subcordate, variable. Indumentum sparse, composed of fine multiseriate hairs, denser along primary and secondary veins abaxially. Scape 5–15 cm, slender, exceeding leaves. Umbel 2–6-flowered; bracts linear-lanceolate, 3–5 mm long. Flowers homostylous. Calyx narrowly campanulate, 4–6 mm; lobes triangular. Corolla rose-purple to lilac with greenish-yellow eye;

tube 8–10 mm, c. 2× calyx length; limb 10–15 mm wide; lobes obovate, deeply 2-cleft.

Distribution and habitat: China (Hengduan Mountains) and Eastern Himalaya. In Bhutan, it is documented from the North-Eastern (Lhuentse) and Central (JSWNP) regions. It occurs in shaded, moist microhabitats between 2300 and 2500 m a.s.l., specifically along forest margins and mossy slopes in cool broadleaved forests.

Specimens examined: BHUTAN. Lhuentse district: Menbi, Zarthang Goenpa, Biological Corridor 7, 27°37'42"N, 91°10'52"E, 2500 m a.s.l., in temperate forest understory, 18 Mar. 2023, R. Dorji, Gyeltshen & N. Tenzin 0003 (THIM!). Trongsa district: Jigme Singye Wangchuck National Park (JSWNP), Black Mountain Base, 27°18'25"N, 90°18'20"E, 2300 m a.s.l., steep stream bank in cool broadleaved forest mixed with conifer, 8 Apr. 2021, S. Tshewang s.n. (photographic record).

Additional specimens examined: CHINA. Xizang (Tibet): Isarong, Salwin-Mekong divide, 1 May 1922, *Forrest 21657* (K!, barcode K000750179).

Taxonomic notes: This species represents a new national record for Bhutan. The population examined in Lhuentse exclusively exhibits homostyly, with anthers and stigma positioned at an equal level near the corolla throat—a significant departure from the distylous condition typical of the genus. While the photographic record from JSWNP confirms the species' presence in Central Bhutan through vegetative and gross floral morphology, further physical collection is required to confirm if the homostylous condition is consistent across its broader Bhutanese range.

Preliminary conservation assessment: Critically Endangered (CR). Within Bhutan, *Primula dumicola* was previously recorded from a single locality in Lhuentse District. The addition of a second record from JSWNP indicates a broader, albeit fragmented, distribution across the temperate forests of North-Eastern and Central Bhutan. Based on these two locations, a preliminary analysis via GeoCAT¹⁵ indicates an Area of Occupancy (AOO) of 8.00 km² and an Extent of Occurrence (EOO) that, while significantly increased from the initial 0.00 km², remains within the threshold for the Endangered category. Although both populations are situated within the national protected area network (Biological Corridor 7 and JSWNP), they remain vulnerable due to their highly specialized microhabitat requirements and small population sizes. The specific threats to

these shaded, mossy microhabitats from localized forest disturbances or climate-induced changes in moisture regimes are not yet fully understood. Consequently, additional field surveys are urgently

required to determine the total population size, identify further potential habitats, and assess specific anthropogenic or environmental threats across its known range.

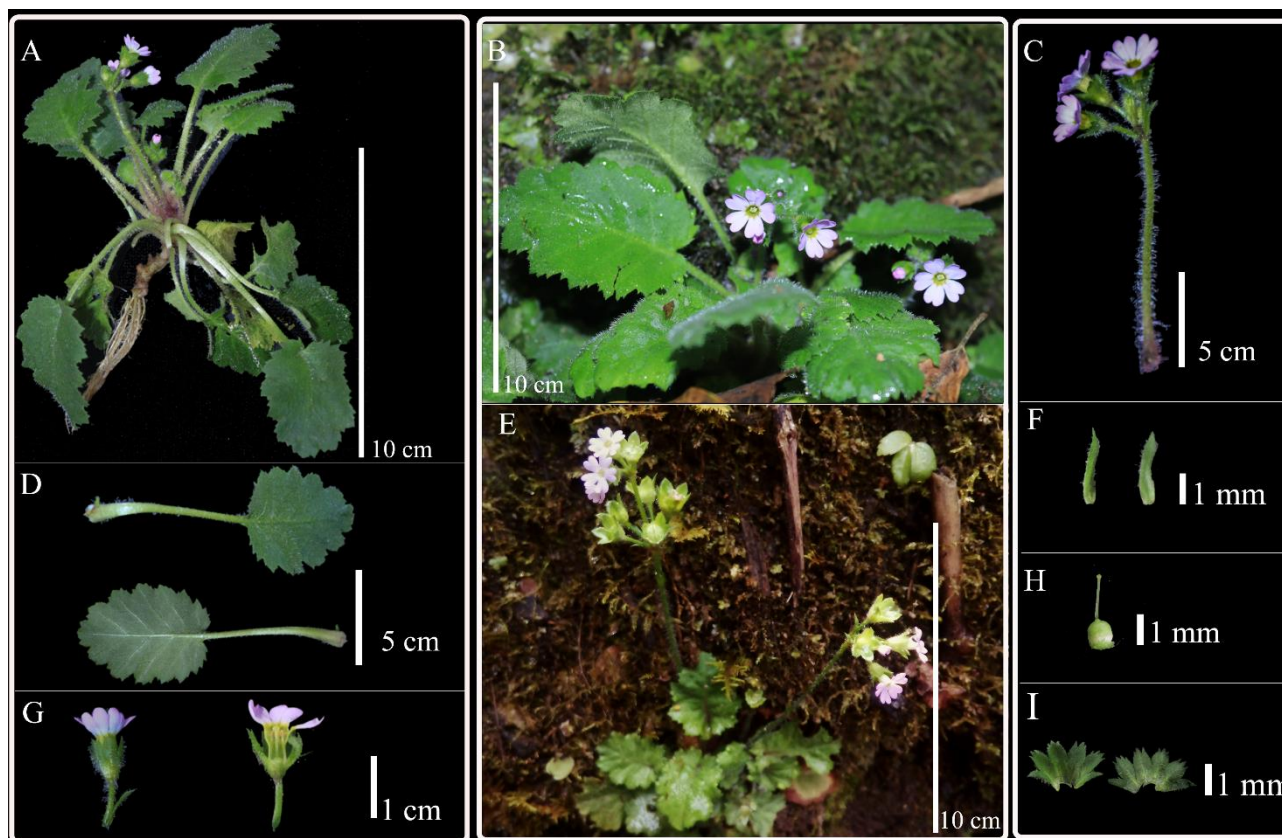


Figure 1. *Primula dumicola* W.W.Sm. **A**, habit showing rhizome and lax leaf rosette; **B**, plant in natural habitat; **C**, inflorescence showing flowers and bracts (from Zarthang); **D**, adaxial and abaxial views of leaves; **E**, flowering habit (from JSWNP); **F**, bracts; **G**, exterior view and longitudinal section of flowers showing homostyly; **H**, gynoecium; **I**, dissected calyx. Scale bars: **A**, **E** = 10 cm; **C**, **D** = 5 cm; **G** = 1 cm; **F**, **H**, **I** = 1 mm. **A–D & F–I**: photographs from Lhuentse by Gyeltshen; **E**: photograph from Black Mountain Base in JSWNP by Sangay Tshewang.

3.1.2. *Primula flagellaris* W.W. Sm., Records of the Botanical Survey of India 4: 219 (1911). (Fig. 2)

Type: INDIA. Sikkim: Lachen, 10,000 ft, 4 Aug. 1909, *Cave s.n.* (holotype: E!, barcode E00273516).¹⁸

Section: *Minutissimae* Pax

Description: Minute, mat-forming perennial herb, producing long, slender, creeping stolons (flagella) rooting at the nodes. Leaves aggregated in small rosettes; lamina oblanceolate to narrowly spatulate, 5–15 mm, apex obtuse to subacute, margin entire or faintly crenulate. Scape is very short or absent. Flowers solitary; pedicel slender. Calyx campanulate, shortly 5-lobed. Corolla purple to violet with a distinct yellow eye; tube short; limb broad in proportion to plant size.

Distribution and habitat: Bhutan (Central, Western, and Eastern regions). Typically occurs on moist cliffs,

open turf, and alpine scree. In Lhuentse, it was recorded at 3026 m a.s.l.

Specimens examined: BHUTAN. Wangdue Phodrang district: Chedebji, 27°29'00"N, 90°19'41"E, 2400 m a.s.l., 15 May 1979, *Grierson & Long 1092* (E!, cited in *Flora of Bhutan*). Trongsa district: Black Mountains, report of stoloniferous variability and habitat (cited in Eveleigh¹⁰). Lhuentse district: Kurtoe, Dungkar, Rinchen Bumpa, Wangchuck Centennial National Park, 27°52'14"N, 91°05'54"E, 3026 m a.s.l., 18 Apr. 2026, N. Shacha s.n. (photographic record, NBC-Portal ID: 9298).

Taxonomic notes: *Primula flagellaris* is distinguished from the sympatric *P. tenella* King ex Watt by its stoloniferous habit; *P. tenella* lacks stolons and forms compact tufts. The present record from Rinchen Bumpa represents a significant eastward range extension from previously known populations in

Central Bhutan. As highlighted in specialized field accounts,¹⁰ the stoloniferous habit is the most reliable diagnostic character for this species. Identification was confirmed by comparing *in situ* morphology with the digitized holotype and verified records from the National Biodiversity Portal. The digital voucher has been deposited in the National Biodiversity Portal (<https://biodiversity.bt/observation/show/940002>) to serve as a permanent reference for the species' eastward distribution in Bhutan.

Preliminary conservation assessment: Endangered (EN). Formally known only from Chendebji (central Bhutan), the species' range is now extended to eastern Bhutan following its discovery at Rinchen Bumpa, Lhuentse District. Despite occurring in two distinct locations, the Extent of Occurrence (EOO) is estimated at 0.00 km² and the Area of Occupancy (AOO) at 8.00 km² via GeoCAT¹⁵. Further field surveys are imperative to quantify population size, delineate the full distribution range, and identify potential threats.



Figure 2. *Primula flagellaris* W.W.Sm. A, habit in situ, showing trailing stolons and rosette clusters on mossy rock surfaces; B, close-up of the flower, noting limb diameter and the relatively long corolla tube; C, detail of a trailing stolon extending from a maternal rosette cluster over the rock substrate. Photographs by Namgay Shacha.

3.2. Orchidaceae

3.2.1. *Liparis sootenzanensis* Fukuy., Reports of the (Annual) Taihoku Botanic Garden 3: 84 (1933). (Fig. 3)

Type: TAIWAN. Shinchiku: *Fukuyama* N. 4104 (holotype: TAI)¹⁹.

Synonyms: *Diteilis sootenzanensis* (Fukuy.) M.A.Clem. & D.L.Jones (2005); *Liparis macrantha* Rolfe var. *sootenzanensis* (Fukuy.) S.S.Ying (1977); *Liparis nigra*

Seidenf. var. *sootenzanensis* (Fukuy.) T.S.Liu & H.J.Su (1978).

Description: Terrestrial herb. Pseudobulbs cylindric, stout, fleshy, 10–15 cm long, 1.3–1.7 cm in diameter. Leaves 2–5; blades ovate-elliptic to elliptic, 10–17 × 6–7.5 cm, amplexicaul, apex acuminate. Inflorescence terminal, 20–26 cm long; rachis 10–15-flowered; floral bracts green, 4–5 mm long. Flowers greenish-yellow or pale green. Sepals linear-oblong, 13–15 × 3–

4 mm, margins revolute. Petals filiform, c. 15 mm long. Lip reflexed near the middle, obovate, 1.5×1 cm, apical margin finely denticulate; disk with two basal calli. Column arcuate, c. 7 mm long.

Distribution and habitat: Taiwan, Vietnam, and Bhutan. In Bhutan, the species is restricted to the eastern districts, where it inhabits moist, shady forest floors at elevations of 1200–1518 m a.s.l. It occurs within subtropical to warm broadleaved forests, associated with a canopy dominated by *Altingia excelsa* Noronha, *Engelhardia spicata* Lesch. ex-Blume, *Eurycorymbus cavaleriei* (Lév.) Rehder & Hand.-Mazz., *Exbucklandia populnea* (R.Br. exGriff.) R.W.Br., *Lithocarpus elegans* (Blume) Hatus. ex Soepadmo, *Quercus glauca* Thunb., *Schima wallichii* (DC.) Korth., and *Syzygium cumini* (L.) Skeels.

Phenology: Flowering from May to July.

Specimens examined: BHUTAN. Punakha district: Goenshari Gewog, Rimchu area, $27^{\circ}40'04''\text{N}$, $89^{\circ}46'08''\text{E}$, 1415 m a.s.l., 29 May 2024, P. Gyeltshen & K. Rabgay 22890, 22891 (THIM!), cited in Gyeltshen et al.⁹ Lhuentse district: Nimshong village,

$27^{\circ}42'35''\text{N}$, $91^{\circ}08'59''\text{E}$, 1440 m a.s.l., 23 Jun. 2020, Gyeltshen 0003 (THIM!).

Taxonomic notes: *Liparis sootenzanensis* is distinguished from the allied *L. nigra* by its pale greenish-yellow flowers and the finely denticulate labellum margin. Previously documented from Punakha in central Bhutan,⁹ the current collection from Nimshong, Lhuentse, represents a significant eastward range extension within the country. Globally, these Bhutanese records mark the westernmost distribution of the species, bridging the gap between the Eastern Himalayas and its known populations in Taiwan and Vietnam.^{20, 21}

Preliminary conservation assessment: **Endangered (EN).** This species is known from Punakha, Lhuentse, and Trashiyangtse. Spatial analysis via GeoCAT¹⁵ yields an EOO of 1,463.194 km² and an AOO of 16.00 km². To better define its conservation trajectory, additional field data regarding population size and potential environmental threats are required.

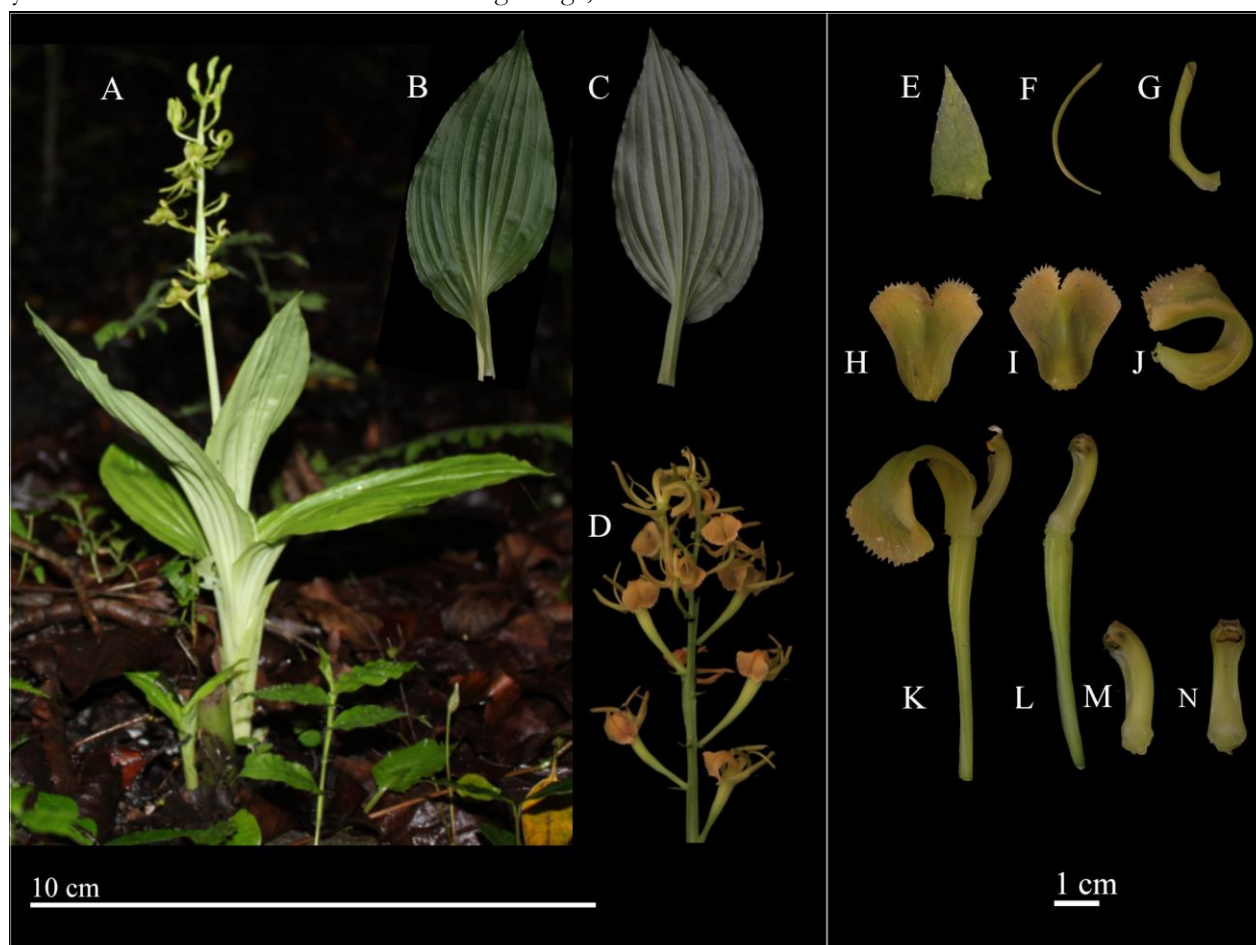


Figure 3. *Liparis sootenzanensis* Fukuy. A, habit; B, leaf (adaxial view); C, leaf (abaxial view); D, inflorescence; E, floral bract; F, petal; G, dorsal sepal; H–J, labellum (various views showing denticulate margin and basal calli); K, flower (lateral view); L, ovary and column (lateral view); M–N, column (ventral and dorsal views). Scale bars: A–D = 10 cm; E–N = 1 cm. Photographs by Gyeltshen.

3.2.2. *Habenaria lucida* Wall. ex Lindl., General Species of Orchidaceous Plants: 312 (1835). (Fig. 4)

Type: MYANMAR [BURMA]. Irrawaddy: Aug. 1826, *Wallich, Cat. No. 7027* (holotype: K-W!, barcode K001127083)²².

Description: Terrestrial herb, 35–60 cm. Tubers oblong-ellipsoid, 2–4 × 1–2 cm. Stem erect, with 3–5 leaves clustered towards the middle. Leaves ovate-lanceolate, 8–15 × 3–5 cm. Inflorescence many-flowered, 15–25 cm long. Flowers small, greenish-white. Dorsal sepal ovate, 4–5 × 2–3 mm; lateral sepals reflexed, 5–6 × 3 mm. Petals bipartite; upper lobe linear, 4–5 mm long; lower lobe filiform, slightly longer. Lip 3-partite; lateral lobes filiform, 6–8 mm long; mid-lobe linear, 5–6 mm long; spur slender, cylindric, 15–20 mm long.

Distribution and habitat: China, India, Myanmar, Thailand, Vietnam, and Bhutan. Recorded from

Tangmachu, Lhuentse, in *Pinus roxburghii* (Chir pine) forests at 1200–1625 m a.s.l.

Phenology: Flowering from August to September.

Specimens examined: BHUTAN. Lhuentse district: Tangmachu, 27°35'32"N, 91°12'08"E, 1625 m a.s.l., 25 Aug. 2020, *Gyeltshen 0004* (THIM!).

Taxonomic notes: *Habenaria lucida* is distinguished from *H. digitata* by its smaller flowers and specific petal lobe proportions. This collection marks a new national record for Bhutan, increasing the national orchid tally to 507 species.

Preliminary conservation assessment: Critically Endangered (CR). The species is assessed as Critically Endangered (CR) based on its new record in Tangmachu, Lhuentse. According to GeoCAT analysis¹⁵, the EOO is 4.00 km² and the AOO is 4.00 km². Additional research is required to quantify population size and identify potential threats to taxon.

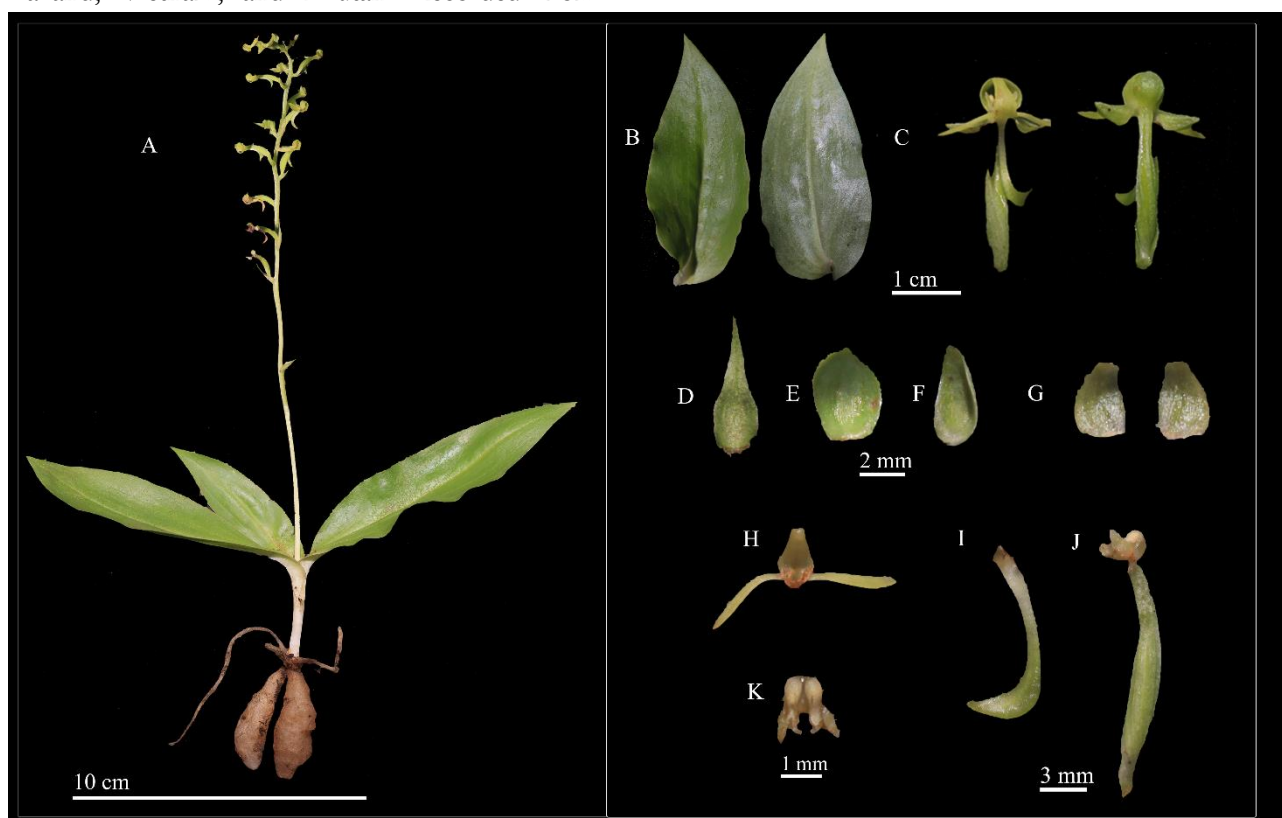


Figure 4. *Habenaria lucida* Wall. ex Lindl. A, habit showing tubers, leaves, and inflorescence; B, leaves (adaxial and abaxial views); C, flowers (front and back views); D, floral bract; E, dorsal sepal; F, lateral sepal; G, bipartite petals; H, 3-partite lip (labellum); I, spur; J, ovary and column (lateral view); K, column (ventral view). Scale bars: A = 10 cm; B–C = 1 cm; D–G = 2 mm; H–J = 3 mm; K = 1 mm. Photographs by Gyeltshen.

Discussion

Taxonomic and evolutionary significance of *Primula*

Primula dumicola is a specialized species of section Obconicolisteri, mainly distributed in Southwest China. Documentation from Lhuentse and JSWNP

extends its known range considerably further west into the Bhutanese highlands. The Lhuentse population is particularly interesting due to its homostylous flower morphology with anthers and stigmas at the same level in the corolla tube²³. This

arrangement is a significant evolutionary break from the distylous (heterostylous) condition found in the *Primula dumicola*. Floral sections and gynoecium morphology clearly indicate that specimens from North-Eastern Bhutan belong to this homostylous form.

As suggested by Zhong et al.,²³ this transition to self-pollination is an evolutionary hallmark that likely enables the species to colonize and persist in isolated, high-altitude "islands" where pollinator services may be unreliable. While the JSWNP record confirms the species' presence in Central Bhutan, further investigation is required to determine if homostyly is a fixed trait across all Bhutanese populations or if it varies with geographic isolation.

In a similar display of high-altitude adaptation, the stoloniferous habit of *P. flagellaris* enables it to colonize alpine screes with high efficiency. By utilizing vegetative spread via runners, *P. flagellaris* can stabilize itself and expand across the shifting, unstable rocky substrates characteristic of the Eastern Himalayan alpine zone. Its documented presence in Lhuentse suggests a continuous, yet previously under-

recorded, distribution across high-altitude corridors⁵. Together, the reproductive strategy of *P. dumicola* and the vegetative resilience of *P. flagellaris* illustrate the diverse evolutionary mechanisms facilitating the survival of Sino-Himalayan flora across rugged terrain.

Additions to the Orchidaceae flora

The addition of *L. sootenzanensis* and *H. lucida* officially updates the orchid flora of Bhutan. While *H. lucida* is widely distributed across the broader Sino-Himalayan region, it had remained elusive in Bhutan until these recent surveys. Its discovery in the Chir pine (*Pinus roxburghii*) forests of Tangmachu highlights the importance of these specific ecological niches. Similarly, the record of *L. sootenzanensis* from Lhuentse and Trashiyangtse represents a significant westward range extension from Southeast Asia. The presence of these species in specific riverine and warm broadleaved ecosystems underscores a critical need for the conservation of these habitats, which are often under-represented in high-altitude protected area management plans (Fig. 5).

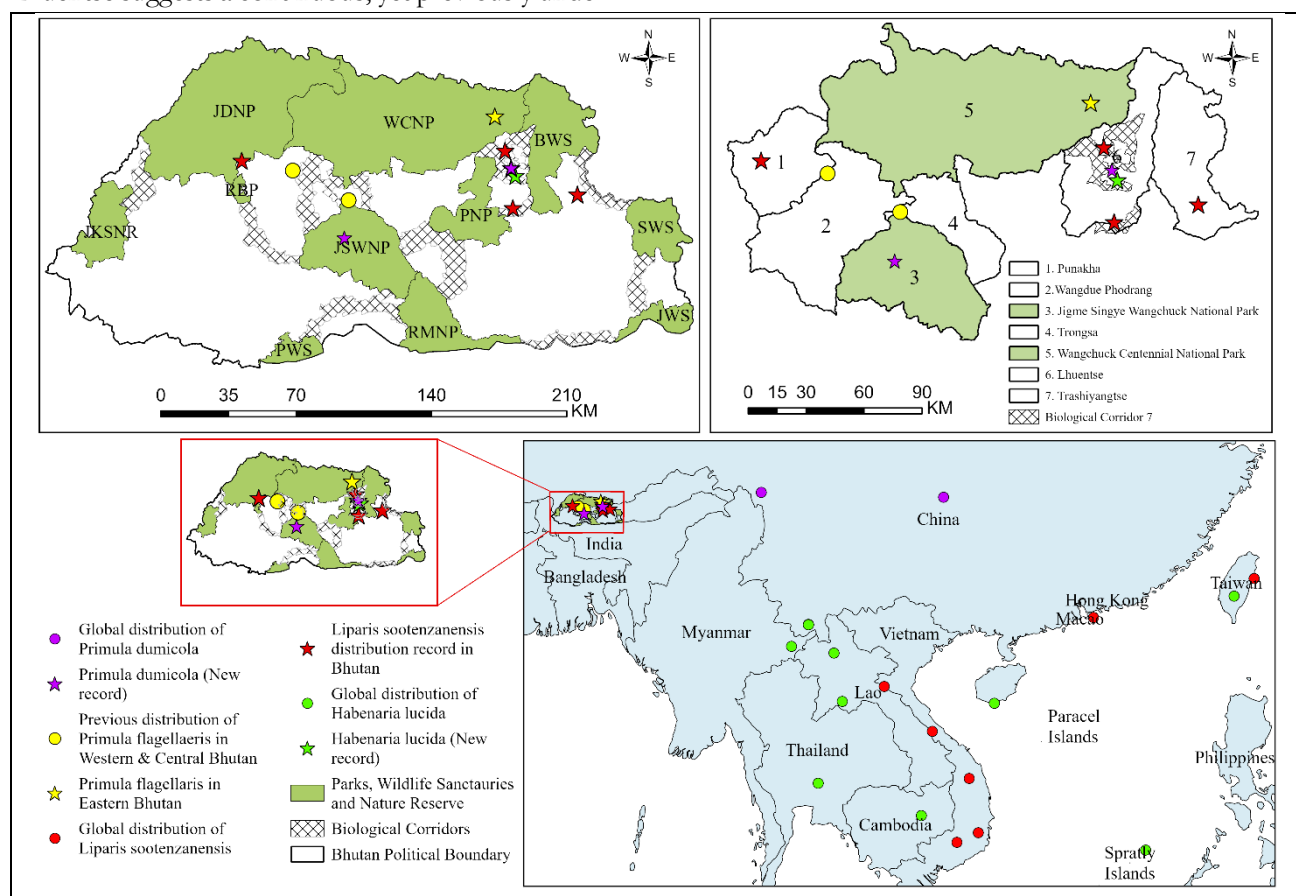


Figure 5. Geographic distribution of four key botanical taxa in Bhutan and across East/Southeast Asia. The main map illustrates specific occurrence records within Bhutan, highlighting new records and range extensions (stars) and previously known distributions (circles) for *Primula dumicola* (purple), *Primula flagellaris* (yellow), *Liparis sootenzanensis* (red), and *Habenaria lucida* (green). Insets provide regional context within the broader Sino-Himalayan and Southeast Asian floristic regions. Map compiled by Gyetlshen.

Biogeographical implications and concluding remarks.

The record of *P. dumicola* across both North-Eastern and Central Bhutan is of profound phytogeographic interest. While the section *Obconicolisteri* was previously considered rare or absent in the region, its presence here reinforces a strong botanical affinity between the Bhutanese highlands and the Hengduan Mountains of China.⁴ These findings suggest that Bhutan's network of protected areas spanning from JSWNP in the center to Lhuentse in the east serves as a primary botanical "bridge". The perceived rarity of certain Sino-Himalayan taxa likely stems from undocumented distributions in remote corridors rather than true absence. Collectively, these records emphasize the necessity of continued botanical exploration in Bhutan's protected landscapes to fully document the region's complex biodiversity.

Conclusion

This study updates the botanical records of Bhutan with two new national findings (*Primula dumicola* and *Habenaria lucida*) and major regional range expansions (*Primula flagellaris* and *Liparis sootenzanensis*). The specialized reproductive variations discovered underscores the evolutionary adaptations running through the Sino-Himalayan corridor. To fully preserve these dynamics, continued field conservation efforts must target the low-to-mid elevation broadleaved river corridors and mountain corridors connecting Bhutan's protected zones.

Acknowledgements

The authors express their deep gratitude to the Department of Forests and Park Services (DoFPS) under the Ministry of Energy and Natural Resources, and the National Biodiversity Centre (NBC) under the Ministry of Agriculture and Livestock, Royal Government of Bhutan, for granting the necessary research permissions, administrative backing, and logistical facilities required to execute this study. We are immensely grateful to the management and field staff of the Ugyen Wangchuck Institute for Forestry Research and Training (UWIFoRT), the Monggar Divisional Forest Office (Lhuentse), and the respective park managements of Jigme Singye Wangchuck National Park (JSWNP) and Wangchuck Centennial National Park (WCNP) for their invaluable assistance during field surveys across remote territorial and high-altitude forest gradients. Special thanks are extended to the curators and technical teams of the National Herbarium of Bhutan

(THIM) for their curation facilities, as well as the administrators of the Bhutan Biodiversity Portal for data archiving. We also express our sincere appreciation to the Royal Botanic Garden Edinburgh (E) and the Royal Botanic Gardens, Kew (K) for maintaining accessible digital type catalogues, which proved vital for remote taxonomic validation. Finally, we thank Pam Eveleigh and the global specialist networks of the *Primula* World project for their generous technical advice and expert taxonomic consultation during the verification of the stoloniferous complex.

Authors' Contribution

Gyeltshen: Conceptualization, Methodology, Software, Mapping, Investigation, Writing - original draft, Project administration. **Ngawang Tenzin:** Investigation, Field sampling, Resources. **Tiger Sangay:** Supervision, Resources. **Sangay Tshewang:** Investigation, Data curation (JSWNP records). **Phuentsho:** Validation, Herbarium verification. **Lam Norbu:** Investigation, Data curation (Trashiyangtse records), Formal analysis. **Rinchen Dorji:** Investigation, Resources, Software. **Namgay Shacha:** Field sampling, Photography.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors. Field logistics were supported by internal operational resources of the Department of Forests and Park Services.

Data Availability Statement

The morphological measurements, specimen numbers, and distribution coordinates supporting the findings of this study have been deposited at the National Herbarium of Bhutan (THIM) and are permanently indexed within the Bhutan Biodiversity Portal dataset repositories. Photographic digital vouchers are publicly referenceable at <https://biodiversity.bt/observation/show/940002>.

Use of AI Statement

The author(s) utilized Gemini (developed by Google) and Grammarly during the writing process to enhance language clarity, correct spelling, and grammatical errors, and ensure appropriate formatting in alignment with *PhytoTalks* journal specifications. These tools were used strictly for language refinement and editing; no original scientific content or data

interpretation was generated by the AI. The final manuscript was thoroughly reviewed and approved by the author(s), who remain fully accountable for its contents.

Data Availability

This article contains data that supports the study.

Ethical Approval

Ethical approval was not required for this study.

References

- Richards AJ. *Primula*. 2nd ed. Timber Press; 2003.
- Hu CM, Kelso S. Primulaceae. In: Wu ZY, Raven PH, eds. *Flora of China*. Vol 15. Science Press; Missouri Botanical Garden Press; 1996:39-189.
- Bawri A, Gajurel PR, Paul A, Khan ML. New distributional records of *Primula* species in Arunachal Pradesh, India. *Biosci Discov*. 2014;5(1):6-10.
- Ward FK. The Sino-Himalayan flora. *Proc Linn Soc Lond*. 1927;139(1):67-74. <https://doi.org/10.1111/j.1095-8312.1927.tb00009.x>
- Grierson AJC, Long DG. *Flora of Bhutan*. Vols 1-3. Royal Botanic Garden Edinburgh; 1983-2002.
- Wu CY. The Sino-Himalayan flora: its characteristics and origins. *Ann Mo Bot Gard*. 1988;75(4):1219-1226. <https://doi.org/10.2307/2399288>
- Pearce NR, Cribb PJ. *The Orchids of Bhutan*. Flora of Bhutan, Vol 3, Part 3. Royal Botanic Garden Edinburgh; Royal Government of Bhutan; 2002.
- Gyeltshen P, Rabgay K, Phuentsho, Kumar P. *Zeuxine drukyulensis* (Orchidaceae), a new jewel orchid from Bhutan Himalaya. *Phytotaxa*. 2025;690:123-129. <https://doi.org/10.11646/phytotaxa.690.1.8>
- Gyeltshen P, Rabgay K, Sangay K, et al. Additions to the orchid flora of Bhutan IV. *Lankesteriana*. 2026;26:11-25.
- Eveleigh P. *Primula World: The Black Mountain (Bhutan) - Primulas and Problems*. *Primula World*. Published April 22, 2026. Accessed April 22, 2026. <https://www.primulaworld.com/>
- Royal Botanic Garden Edinburgh. Herbarium Catalogue. Accessed April 22, 2026. <https://data.rbge.org.uk/herb/>
- Royal Botanic Gardens, Kew. Kew Herbarium Catalogue. Accessed April 22, 2026. <http://apps.kew.org/herbcat/>
- GBIF.org. GBIF Occurrence Download. Accessed April 23, 2026. <https://doi.org/10.15468/dl.4xs8qd>
- International Union for Conservation of Nature (IUCN). *IUCN Red List Categories and Criteria: Version 3.1*. 2nd ed. IUCN; 2012.
- Bachman S, Moat J, Hill AW, de la Torre J, Scott B. Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys*. 2011;150:117-126. <https://doi.org/10.3897/zookeys.150.2109>
- International Union for Conservation of Nature (IUCN). *Mapping Standards and Data Quality for the IUCN Red List Categories and Criteria*. Version 1.16. IUCN; 2018.
- Smith WW. New species of *Primula*. *Notes Roy Bot Gard Edinburgh*. 1926;15:233-238. <https://doi.org/10.24823/nrbge.1926.2331>
- Smith WW. Some additions to the flora of the Eastern Himalaya. *Rec Bot Surv India*. 1911;4(5):219-231.
- Fukuyama N. *Studia Orchidacearum Japonicarum I. Rep Taihoku Bot Gard*. 1933;3:81-86.
- Averyanov LV, Nguyen KS, Tichy HN, Nguyen PH. New species of Orchidaceae from Vietnam. *Wulfenia*. 2016;23:85-117.
- Chen X, Ormerod P, Wood JJ. *Liparis*. In: Wu ZY, Raven PH, Hong DY, eds. *Flora of China*. Vol 25. Orchidaceae. Science Press; Missouri Botanical Garden Press; 2009:211-228.
- Lindley J. *The Genera and Species of Orchidaceous Plants*. Ridgways; 1830-1840. <https://doi.org/10.5962/bhl.title.499>
- Zhong L, Liu J, Shao JJ, et al. Phylogenomic analysis reveals multiple evolutionary origins of selfing in *Primula* section *Obconicolisteri*. *New Phytol*. 2023;239(6):2351-2364. <https://doi.org/10.1111/nph.19136>