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GENTIANA ARUNII SP. NOV.: TINY REMARKABLE *GENTIANA* FROM SIKKIM HIMALAYA

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A new species, *Gentiana arunii* D.Maity, S.K.Dey, J.Ghosh & Midday, from alpine pasture in Sikkim Himalaya is described and illustrated, and placed in *Gentiana* section *Chondrophyllae* Bunge. The new species is compared morphologically with two related taxa, *Gentiana glabriuscula* T.N.Ho and *Gentiana pluviarum* W.W.Sm. subsp. *subtilis* (Harry Sm.) T.N.Ho.

Keywords. Chondrophyllae, Gentianaceae, IUCN status.

Introduction

Gentiana L. (Gentianaceae) comprises about 362 species and is widely distributed in the temperate and alpine regions of north-west Africa (Morocco), America, Asia, east Australia and Europe (Ho & Pringle, 1995; Mabberley, 2008). The genus is credited with more than 65 species in India; most of them are found in the Himalayas, whereas the Western Ghats harbour only two species (Clarke, 1883; Garg, 1987; Sasidharan, 2004; Maity, 2014; Anilkumar *et al.*, 2015).

In 2015, during an expedition to North Sikkim, a few specimens of an attractive *Gentiana* were collected from alpine pastures. The plants were remarkable by their tiny size, mostly to 1 cm (occasionally to 1.5 cm) high with a simple stem having a solitary terminal white flower with a blue tinge outside around the throat. Moreover, the calyx lobes had deflexed purple tips. To determine the variability in growth form, if any, it was decided by our research team not to publish the taxonomy of the plant immediately. Later, in two successive years, 2016 and 2017, we observed the populations and collected representative specimens with similar morphology. A detailed literature search (Clarke, 1883; Garg, 1987; Ubolcholaket, 1987; Ho & Liu, 1993; Ho & Pringle, 1995; Aitken, 1999; Ho & Liu, 2001; Hul, 2003), subsequent morphotaxonomic examinations of the specimens, and comparisons with almost all *Gentiana* species of the Himalaya (India, Nepal, Bhutan and Tibet) reveal that this species belongs to *Gentiana* section *Chondrophyllae* Bunge, and morphologically resembles *Gentiana glabriuscula* T.N.Ho and *Gentiana pluviarum* W.W.Sm. subsp. *subtilis* (Harry Sm.) T.N.Ho, but differs notably in its significantly smaller size, its simple stem with solitary terminal 4-merous white flower, the presence of basal leaves at anthesis, its obovate

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stem leaves with acute apex having deflexed cartilaginous mucro, emarginate/retuse plicae and filaments being attached near the middle of the corolla tube. A detailed description, illustration and images of the new species are provided to facilitate its identification. A comparison of this new taxon to *Gentiana glabriuscula* and *G. pluviarum* subsp. *subtilis* is also provided (Table 1).

Species Description

Gentiana arunii D.Maity, S.K.Dey, J.Ghosh & Midday **sp. nov.**

Akin to *Gentiana glabriuscula* Ho but plants smaller, mostly to 1 cm high (occasionally to 1.5 cm); basal leaves 4, dimorphic, smaller, to 2 × 1.5 mm, present at anthesis, basal-most two with rounded apex; stem leaves reflexed only by apical third part; flowers 4-merous, white with bluish tinge outside around throat; calyx, corolla lobes, filaments and anthers smaller; ovary ovoid–ellipsoid, smaller. Moreover, *Gentiana arunii* is found at much higher elevations than *G. glabriuscula* (c.4600 m versus up to 3200 m). The new species is also close to *Gentiana pluviarum* subsp. *subtilis* (≡ *Gentiana subtilis* Harry Sm.) but differs in plants being smaller, mostly to 1 cm high (occasionally to 1.5 cm); basal leaves 4, dimorphic; stem simple with solitary, terminal, 4-merous white flower with bluish tinge outside around throat; basal leaves present at anthesis; stem leaves elliptic–ovate with acute apex with deflexed cartilaginous mucro; plicae emarginate/retuse; and filaments being attached near the middle of corolla tube. Type – Upper Thangu Valley, 4600 m, 9 viii 2015, *Maity & Dey* 21885 (holo CUH; iso CAL, CUH). **Figs 1**, **2**.

Annual, erect herb, 0.6–1(–1.5) cm tall. *Taproot* cylindrical, to 2.5 cm long, c.0.1 mm diameter. *Stems* simple, glabrous. *Basal rosette leaves* 4, present during anthesis, dimorphic; basal-most leaf blades broadly elliptic or suborbicular, 1.5–2 × 1–1.5 mm, apex rounded, margin entire, smooth, slightly cartilaginous, petioles short, to 0.2 mm, base fused to c.0.25 mm long sheath, glabrous, vein not prominent, with few papillae at node; other two leaf blades oblanceolate–oblong, 1.4–1.6 × 1–1.2 mm, apex acute, mucronate; mucro reflexed, cartilaginous; margin entire, slightly cartilaginous, midvein ± prominent. *Stem leaves* lax, 2–4 pairs, longer or shorter than internodes; petioles fused, forming a sheath 0.25–0.5 mm long, smooth; leaf blade oblanceolate–elliptic or oblanceolate–oblong, 1.5–2 × 1–1.1 mm, leathery, smooth, apex acute, often purplish, mucronate; mucro cartilaginous, recurved; upper two-thirds margin entire, lower third papillate, slightly cartilaginous, vein 1, strongly cartilaginous, winged (prominent when dry), without distinct petiole, reflexed only in apical third part. *Flowers* terminal, solitary, 4-merous; uppermost node (below flower) minutely papillate; pedicels to 1.7 mm long, often surrounded by uppermost pair of leaves, glabrous. *Calyx* campanulate, 2.5–3 × 1–1.5 mm; tube 1.6–2 mm long, with prominent veins; lobes 4, ovate (obovate–oblong), 0.9–1 × 0.5–0.8 mm, subequal, margin slightly cartilaginous, apex caudate–mucronate, often purplish, 1-veined, moderately reflexed; midvein cartilaginous. *Corolla* campanulate, 3.4–4.2 mm, white with blue tinge on outside around throat, greenish towards base; tube 3–3.5 mm; lobes broadly ovate, 0.4–0.7 × 0.9–1 mm, apex acute, mucronate; plicae broadly ovate, 0.2–0.3 × 0.7–

TABLE 1. Comparison of the morphological features of *Gentiana arunii* sp. nov., *Gentiana glabriuscula* Ho and *Gentiana pluviarum* W.W.Sm. subsp. *subtilis* (Harry Sm.) T.N.Ho

Character	*Gentiana arunii* sp. nov.	*Gentiana glabriuscula*	*Gentiana pluviarum* subsp. *subtilis*
Habitat	Around 4600 m	2440–3170 m	3700–4200 m
Habit	Annual, to 1(–1.5) cm tall	Annual or biennial, to 5 cm	Annual, to 4.5 cm
Branching pattern	Unbranched	Branched from base, caespitose	Branched from base
Lamina (basal rosette)			
Number	4, dimorphic (lower, 2; upper, 2)	Few, undifferentiated	Few, undifferentiated
Nature	Present at anthesis	Present at anthesis	Withered at anthesis
Shape	Lower: broadly elliptic or suborbicular Upper: oblanceolate–oblong	Broadly ovate to orbicular or oblong	Spatulate
Size	Lower: 1.5–2 × 1–1.5 mm Upper: 1.4–1.6 × 1–1.2 mm	6–26 × 3–15 mm	2.5–6 × 1–2 mm
Apex	Lower: rounded Upper: acute	Rounded	Acute
Margin	Lower: entire Upper: entire	Entire	Entire
Petiole	Absent	3–5 mm	1–1.2 mm
Stem leaf lamina			
Shape	Oblanceolate–elliptic or oblanceolate–oblong	Ovate	Spatulate to elliptic
Size	1.5–2 × 1–1.1 mm	3–7 × 2–3.5 mm	1–2.2 × 0.6–1 cm
Apex	Acute, mucronate	Acute, mucronate	Obtuse
Margin	Upper two-thirds margin entire, lower third papillate	Entire, slightly undulate	Entire
Pedicel	To 1.7 mm	Absent	0.5–1 mm
Flower	Terminal, solitary, 4-merous, white with blue tinge on outside around throat, greenish towards base	Terminal, solitary, 5-merous, pale greyish or bright blue, with darker spots in the throat	Terminal, few to many, 5-merous, white, with (4 or) 5 large blackish spots in throat

TABLE 1. *(Continued)*

Character	*Gentiana arunii* sp. nov.	*Gentiana glabriuscula*	*Gentiana pluviarum* subsp. *subtilis*
Calyx			
Tube	1.6–2 mm	(1.5–)3–4 mm	1.8–2 mm
Lobe: nature	Subequal	Equal	Equal
Lobe: shape	Ovate or obovate–oblong	Broadly spathulate or ovate	Lanceolate to elliptic
Lobe: size	0.9–1 × 0.5–0.8 mm	1.5–3 × 1–2 mm	1.2–1.5 mm
Corolla			
Shape	Campanulate	Campanulate	Tubular
Size	3.4–4.2 mm	5–7.5 mm	4–5 mm
Tube	3–3.5 mm	4–5 mm	3.6–4.4 mm
Lobe: shape	Broadly ovate	Ovate	Ovate
Lobe: size	0.4–0.7 × 0.9–1 mm	1–2.5 × 1 mm	0.4–0.6 mm
Lobe: apex	Acute	Acute to acuminate	Obtuse
Plicae			
Shape	Broadly ovate	Ovate to broadly ovate	Ovate
Size	0.2–0.3 × 0.7–0.8 mm	c.1 mm	0.3–0.5 mm
Apex	Emarginate(–retuse)	Acute, irregular, entire or bifid (bilobed)	Obtuse
Stamens	Inserted towards middle of corolla tube	Inserted at middle part of corolla tube	Inserted at basal part of corolla tube
Filaments	0.7–0.8 mm	1–1.5 mm	0.7–1 mm
Ovary	Ovoid–ellipsoid, 0.8–1.1 × 0.3 mm	Obovoid–oblongoid, c.2 × 1 mm	–
Style	0.4–0.6 mm	0.5 mm	0.3–0.4 mm
Stigma lobes	Narrowly ovate–oblong	Oblong	Ellipsoid
Ovarian stipe	0.3–0.4 mm	c.4 mm	3–5 mm

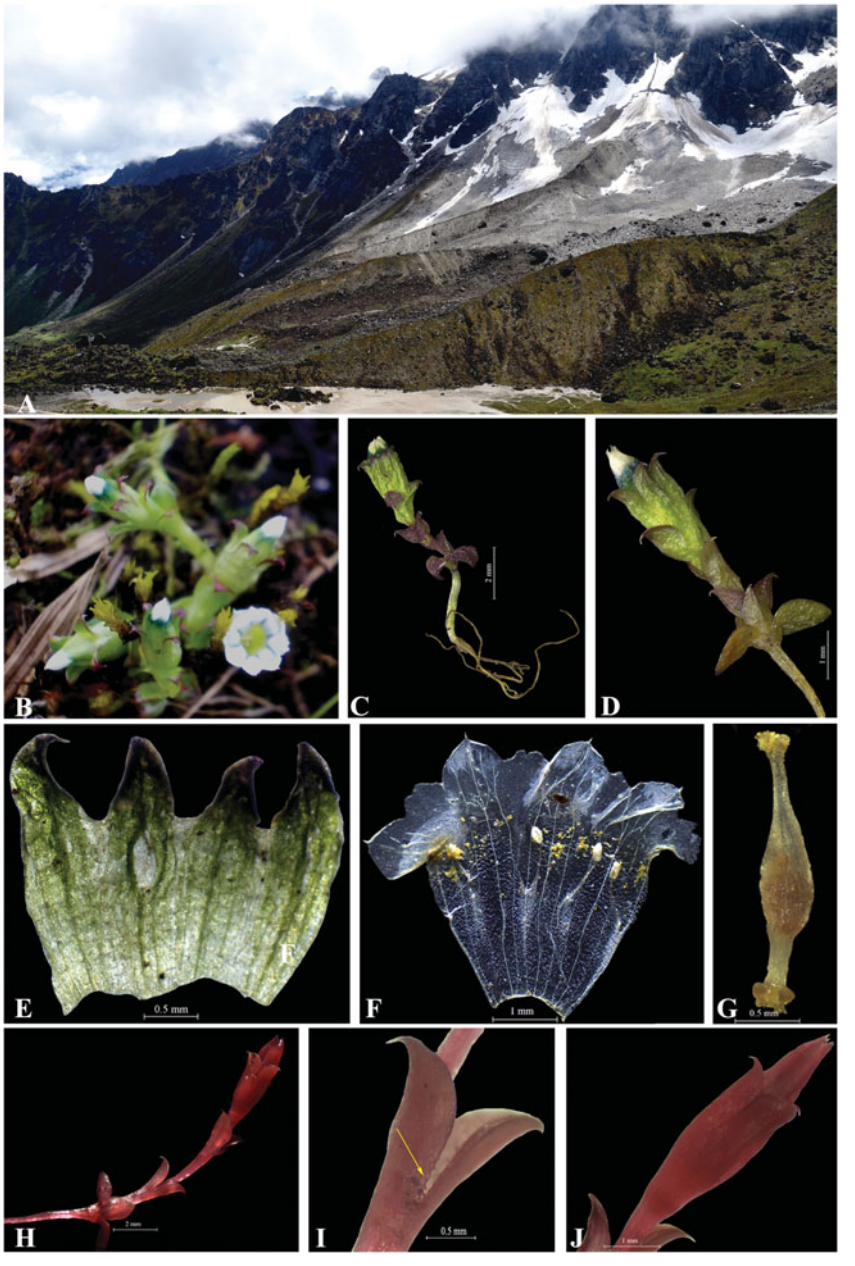

FIG. 1. *Gentiana arunii* D.Maity, S.K.Dey, J.Ghosh & Midday. A, Habitat; B, plants with flowers; C, dried whole plant; D, dried plant soaked in water; E, split calyx (ventral face); F, split corolla showing epipetalous stamens (ventral face); G, gynoecium; H, cleared and stained plant; I, stained leaves (pair), note papillate margin marked with arrow; J, cleared and stained flower bud.

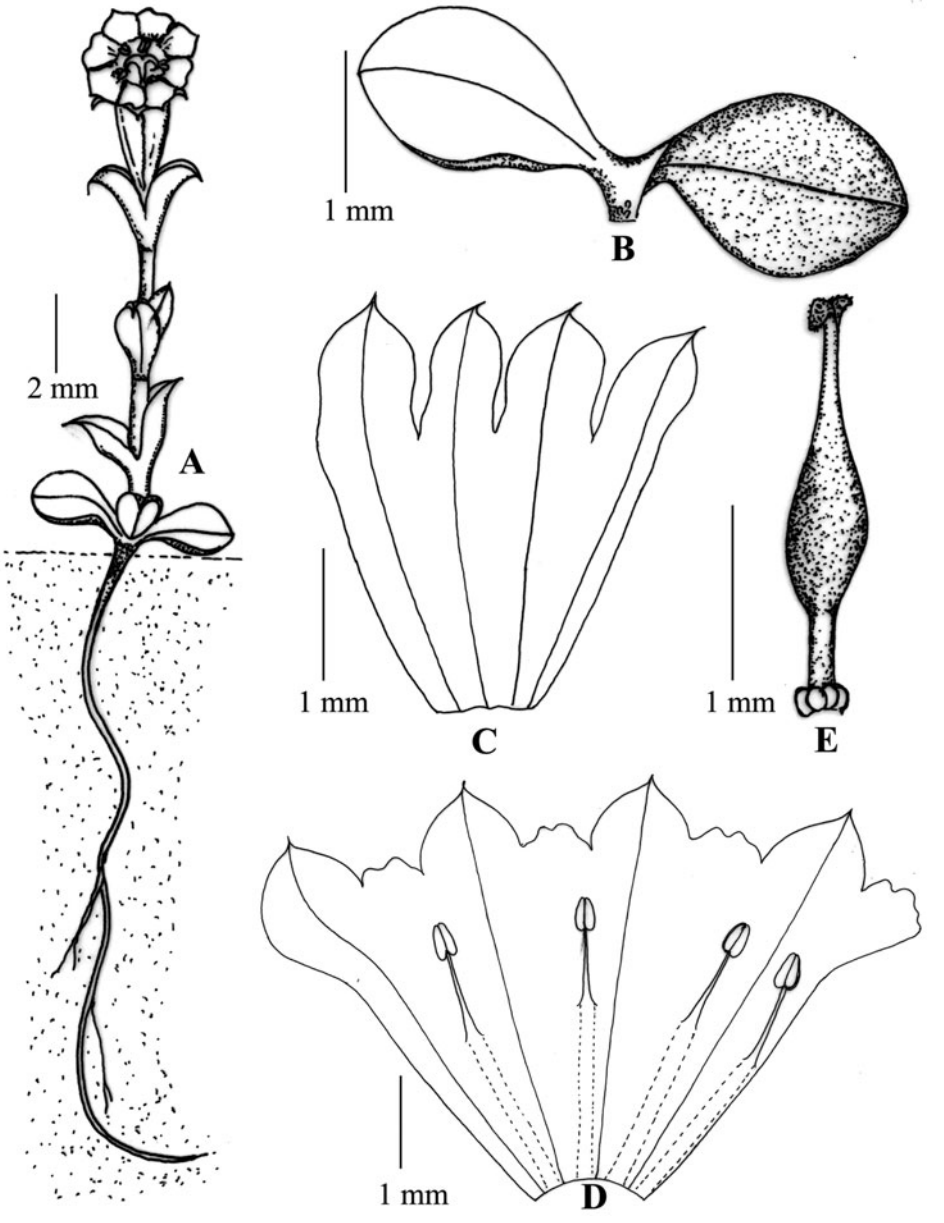

FIG. 2. *Gentiana arunii* D.Maity, S.K.Dey, J.Ghosh & Midday. A, Habit; B, lowermost leaf pair of basal rosette; C, split calyx (ventral face); D, split corolla showing epipetalous stamens (ventral face); E, gynoecium.

0.8 mm, emarginate(–retuse). *Stamens* inserted towards middle of corolla tube, 1.1–1.8 mm above corolla base; filaments 0.7–0.8 mm long, white, flattened towards base; anthers 0.2–0.3 mm long, yellow; ovary ovoid–ellipsoid, 0.8–1.1 × 0.3 mm. *Ovarian stipe* 0.3–0.4 mm long; style 0.4–0.6 mm long; stigma lobes narrowly ovate–oblong, c.0.2 mm.

Distribution. Sikkim, probably endemic.

Habitat. Plants growing on grassy slopes in open alpine forests at around 4600 m a.s.l. As well as the specimens collected, several individuals along with young plants and seedlings were observed. The common associated species are *Aletris pauciflora* (Klotzsch) Hand.-Mazz., *Bistorta affinis* (D.Don) Greene, *Corydalis meifolia* Wall., *Diplarche multiflora* Hook.f. & Thomson, *Diplarche pauciflora* Hook.f. & Thomson, *Gentiana phyllocalyx* C.B.Clarke, *Gentiana springateana* D.Maity, *Koenigia nummulariifolia* (Meisn.) Měsíček & Soják, *Kuepferia kanchii* D.Maity, S.K.Dey & Adr.Favre, *Kuepferia infelix* (C.B.Clarke) Adr.Favre, *Ranunculus* L. spp., etc.

Flowering. July to August.

Proposed IUCN conservation status. Critically Endangered (CR). *Gentiana arunii* is presently known from two populations, each having 10–15 individuals in the small state of Sikkim. It is geographically restricted. The area of occupancy and extent of occurrence of the species are < 10 km^2 and < 100 km^2, respectively. The species must be considered at high risk, owing to its limited geographical range and the fact that the populations occur along a road with high anthropogenic activity on open slopes. Therefore, we propose the IUCN conservation category Critically Endangered (CR B&D) for this species (IUCN Standards and Petitions Subcommittee, 2016).

Etymology. The specific epithet commemorates late Prof. (Dr.) Arun Kumar Sharma (1943–2017), Padma Bhushan, a legendary cytotaxonomist of the Department of Botany, University of Calcutta, who made great contributions to the cytology of Himalayan plants.

Additional specimens examined (paratypes). Sikkim. **Upper Thangu Valley**: 4600 m, 9 viii 2015, *Maity & Dey* 21886; 4600 m, 29 vii 2017, *Maity & Dey* 20123; 4600 m, 21 vii 2017, *Dey, Ghosh & Midday* 22410, 22411 (CUH).

Discussion

The new species, *Gentiana arunii*, has attracted attention primarily by its tiny habit, usually under 1 cm high, and could be the smallest species of the genus known to date. This small plant with its simple stem bears one terminal, white, 4-merous flower, a dimorphic (2 + 2) basal leaf rosette and is unparallelled among all known species in the Himalaya, as such a combination of characters is not found in any other known taxon of the genus. The habit of the species was confirmed by visits in three successive years (since 2015) to confirm the stability of the morphological characters,

particularly the height of the plants and the colour of the flowers. These observations confirm the diagnosis of this remarkable little plant and its affinity to *Gentiana glabriuscula* and *G. pluviarum* subsp. *subtilis*. *Gentiana arunii* is significantly smaller in almost every respect than its relative *G. glabriuscula*; furthermore, qualitatively it is also very different. A number of characters distinguish the new species from *Gentiana glabriuscula*, viz. those of the stem (simple versus branched, caespitose), basal leaves (dimorphic, up to 2 × 1.5 mm, sessile versus uniform, 6–26 × 3–15 mm, long-petiolate to 5 mm), stem leaves (oblanceolate–elliptic or oblanceolate–oblong versus ovate), pedicels (prominent, to 1.7 mm long versus absent), flowers (4-merous versus 5-merous), calyx lobes (subequal versus equal) and corolla colour (uniform inside versus darker spots in throat). Moreover, the plicae in *Gentiana arunii* are emarginate(–retuse), in contrast to the acute, irregular, entire or bifid (bilobed) plicae in *G. glabriuscula*.

Similarly, the new species differs from another allied taxon *Gentiana pluviarum* subsp. *subtilis* not only by its smaller size, but also by many significant qualitative characters, viz. the nature of the stem (simple versus branched from base), basal leaves (present at anthesis versus withered at anthesis), stem leaves (sessile, papillate along lower third margin versus prominently petiolate, entire throughout margin), flowers (4-merous versus 5-merous), calyx lobes (subequal versus equal), corolla shape (campanulate versus tubular) and corolla colour (uniform white within versus white with [4 or] 5 blackish spots in throat). Notably, the plicae in *Gentiana arunii* have emarginate(–retuse) apices, whereas in *G. pluviarum* subsp. *subtilis* the plicae are obtuse.

The new species shows some morphological similarity with *Gentiana pedicellata* (Wall. ex D.Don) Griseb., viz. elliptic or lanceolate basal leaves, elliptic, oblanceolate or spathulate stem leaves, ovate or broadly ovate corolla lobes and ellipsoid ovary. However, the later species has a large, much branched growth form (often to 10 cm high) and glandular–papillose stems and leaves. Moreover, leaves are much larger and flowers are in a loose cyme in *Gentiana pedicellata*; *G. arunii* has smaller leaves and a solitary flower. *Gentiana arunii* also occurs at higher altitudes than the other three species.

Molecular phylogenetic studies may reveal the relationships of these four taxa in the future. The annual habit and solitary terminal flowers with symmetrical plicae place this species in *Gentiana* sect. *Chondrophyllae* (Ho & Pringle, 1995). Severe anthropogenic activity around the type locality have been observed in recent years, therefore immediate action should be taken by the competent authorities to save this remarkable little plant.

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