

LOMATOGONIUM GAURGOPALII, A NEW SPECIES OF GENTIANACEAE FROM SIKKIM HIMALAYA

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Lomatogonium gaurgopalii sp. nov., a new species of Gentianaceae from Sikkim Himalaya, is described and illustrated. It can be distinguished from its morphologically closest relative, *Lomatogonium cherukurianum* S.K.Dey & D.Maity, mainly by its robust habit, longer internodes, much larger creamy yellow flower and much larger floral parts; the presence of many hairs in an inverted semilunar arrangement behind the filament bases; and its larger, narrowly ovoid to narrowly ellipsoid ovary. *Lomatogonium gaurgopalii* is also unique in having pollen grains with striate-reticulate exine ornamentation without perforations.

Keywords. Conservation, IUCN status, phytosociology, pollen exine architecture.

INTRODUCTION

The genus *Lomatogonium* A.Braun of the family Gentianaceae currently includes about 24 accepted species worldwide, of which there are 16 in China, 12 in India, two in Europe and only one in North America (Liu & Ho, 1992; Ho & Pringle, 1995; Dey & Maity, 2017; Mabberley, 2017). The greatest species diversity of the genus is concentrated in the cool temperate and alpine Himalayas. The number of species in India has increased recently to 12 (Dey & Maity, 2017), almost equally shared between the Western and Eastern Himalayas. Notably, nine species grow in Sikkim (Clarke, 1883; Garg, 1987; Aitken, 1999; Aitken & Long, 2010; Dey & Maity, 2017; Maity *et al.*, 2018).

During a recent botanical expedition to the alpine mountains of North Sikkim, a few unusual populations of *Lomatogonium* were discovered by our research team in the lower Gurudongmar valley. At first glance, the material collected resembles the recently described *Lomatogonium cherukurianum* S.K.Dey & D.Maity from the Lhonak valley of Sikkim (Dey & Maity, 2017). However, the plants grow in dense clumps, have a taller, more robust growth habit and bear much larger yellowish flowers (4–5 cm in diameter). Moreover, *Lomatogonium cherukurianum* is an early-flowering species (July), whereas the proposed new species flowers in September. Detailed morphological characterisation and comparisons with morphologically similar species support recognition of these unknown populations as a distinct species new to science.

The present study is fundamentally based on a comprehensive literature search related to the taxonomy of the genus *Lomatogonium* and the family Gentianaceae (Clarke, 1883; Garg, 1987; Liu & Ho, 1992; Ho & Pringle, 1995; Aitken, 1999; Aitken & Long, 2010;

Dey & Maity, 2017; Maity *et al.*, 2018). A table and key are provided for the easy recognition and correct identification of the proposed new species and its allies.

MATERIALS AND METHODS

Material (nine plants from three populations) was collected from alpine pasture in the high Himalayan mountains of the state of Sikkim. Morphological data for the new species and for its ally *Lomatogonium cherukurianum* were obtained from these collections and from Dey & Maity (2017), respectively. All previous collections, including type specimens of *Lomatogonium cherukurianum*, were examined critically. Morphological data for other species related to this group were obtained from Clarke (1883), Garg (1987), Ho & Pringle (1995), Aitken (1999), Dey & Maity (2017) and Maity *et al.* (2018).

Measurements of vegetative and floral parts were scored under a stereomicroscope (Leica EZ4E, Wetzlar, Germany). Type specimens were prepared and deposited in CUH and CAL. Conservation assessments were made following *IUCN Red List Categories and Criteria* (IUCN Standards and Petitions Subcommittee, 2017). Pollen grains were characterised through scanning electron microscopy, with description of individual pollen grains based on Erdtman (1952).

SPECIES DESCRIPTION

***Lomatogonium gaurgopalii* D.Maity, Middy & J.Ghosh, sp. nov.**

Morphologically close to *Lomatogonium cherukurianum* S.K.Dey & D.Maity (also in Sikkim Himalaya) but differing in its taller, more robust growth habit, many larger basal leaves, longer internodes, larger stem leaves in 2 or 3 pairs, longer pedicel, creamy yellow larger flowers (4–5 cm in diameter) and much larger floral parts; the presence of many rigid hairs on the adaxial side of the corolla in an inverted semilunar arrangement behind the filament bases; and its larger nectaries, larger filaments and much larger narrowly ovoid to narrowly ellipsoid ovary. Moreover, individuals of the new species grow in dense clumps with the stem leaves never fused at the base, and have a longer calyx and corolla tube, stamens and nectaries attached higher above the corolla base, and pollen grains with striate-reticulate ornamentation without perforations. – Type: India, Sikkim, about 5 km before Gurudongmar, about 3 km from river, 4500 m, 1 ix 2018, *Middy & Ghosh* 23831 (holo CUH; iso CAL, CUH). **Figs 1, 2.**

Perennial, (5–)6–12.5 cm tall. *Rhizomes* thick, 1–1.5 mm in diameter, branched, horizontal, covered with blackish bark and sheathed by blackish remains of old petioles below basal leaves. *Stems* erect, simple, ± angular, glabrous. *Leaves* mostly basal, lanceolate, 1.5–3.5 × 0.3–0.5 cm, apex subacute, midvein distinct, raised below, with one strong lateral vein on each side, glabrous, petiolate; petioles 0.6–1.2 cm long, often weakly differentiated; stem leaves in 2 or 3 pairs, lanceolate, 1.1–3.5 × 0.2–0.5 cm, entire, acute or subacute, sessile, free; internodes (0.5–)1–2.7 cm long, shorter or longer than leaves. *Flower* terminal, solitary,

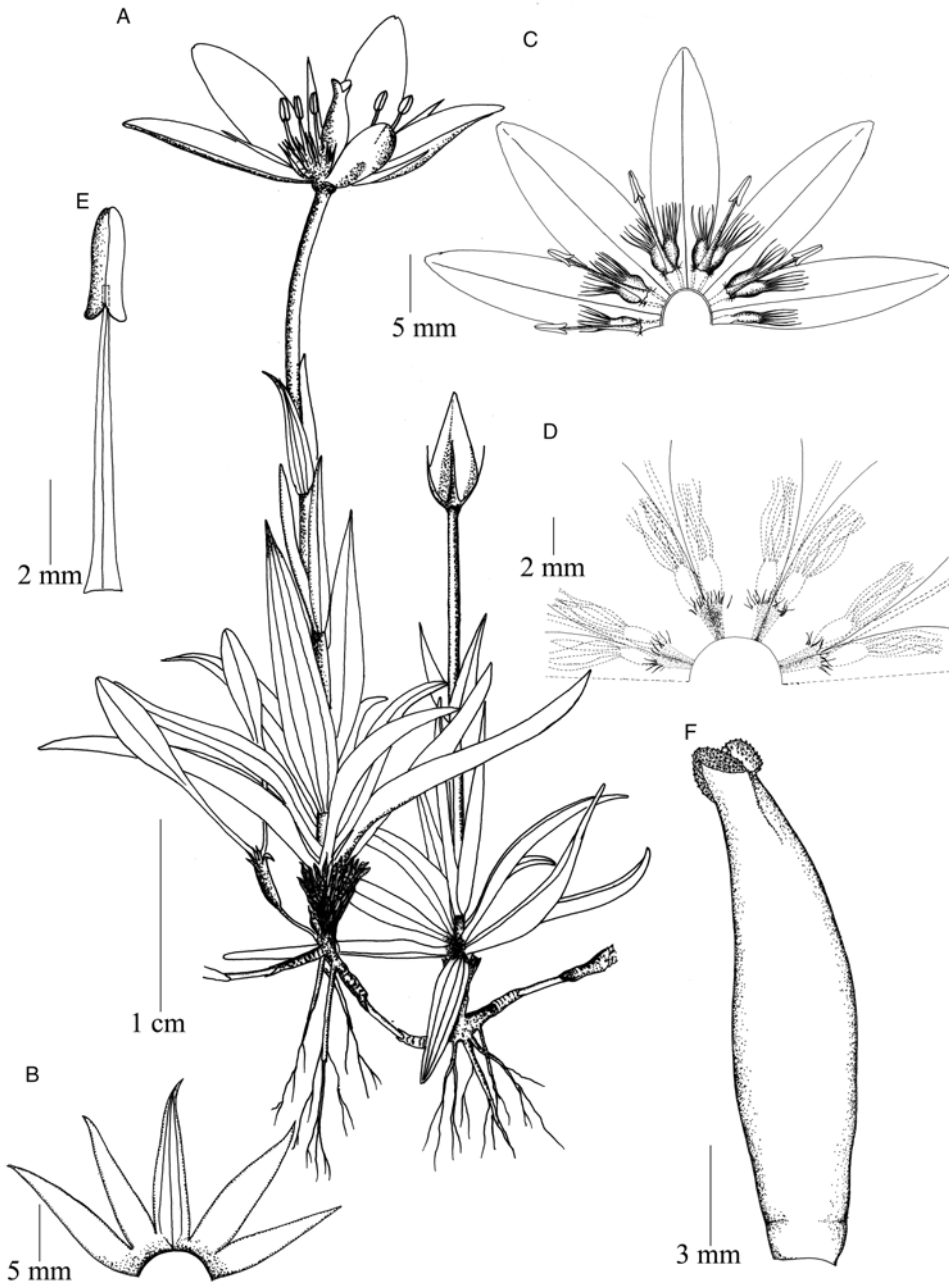


FIG. 1. *Lomatogonium gaurgopalii* sp. nov. A, Habit; B, split calyx (dorsal face); C, split corolla, stamens and nectaries (adaxial face); D, part of split corolla (adaxial face) – note hairs in inverted semilunar pattern behind filament bases; E, stamens; F, gynoecium.

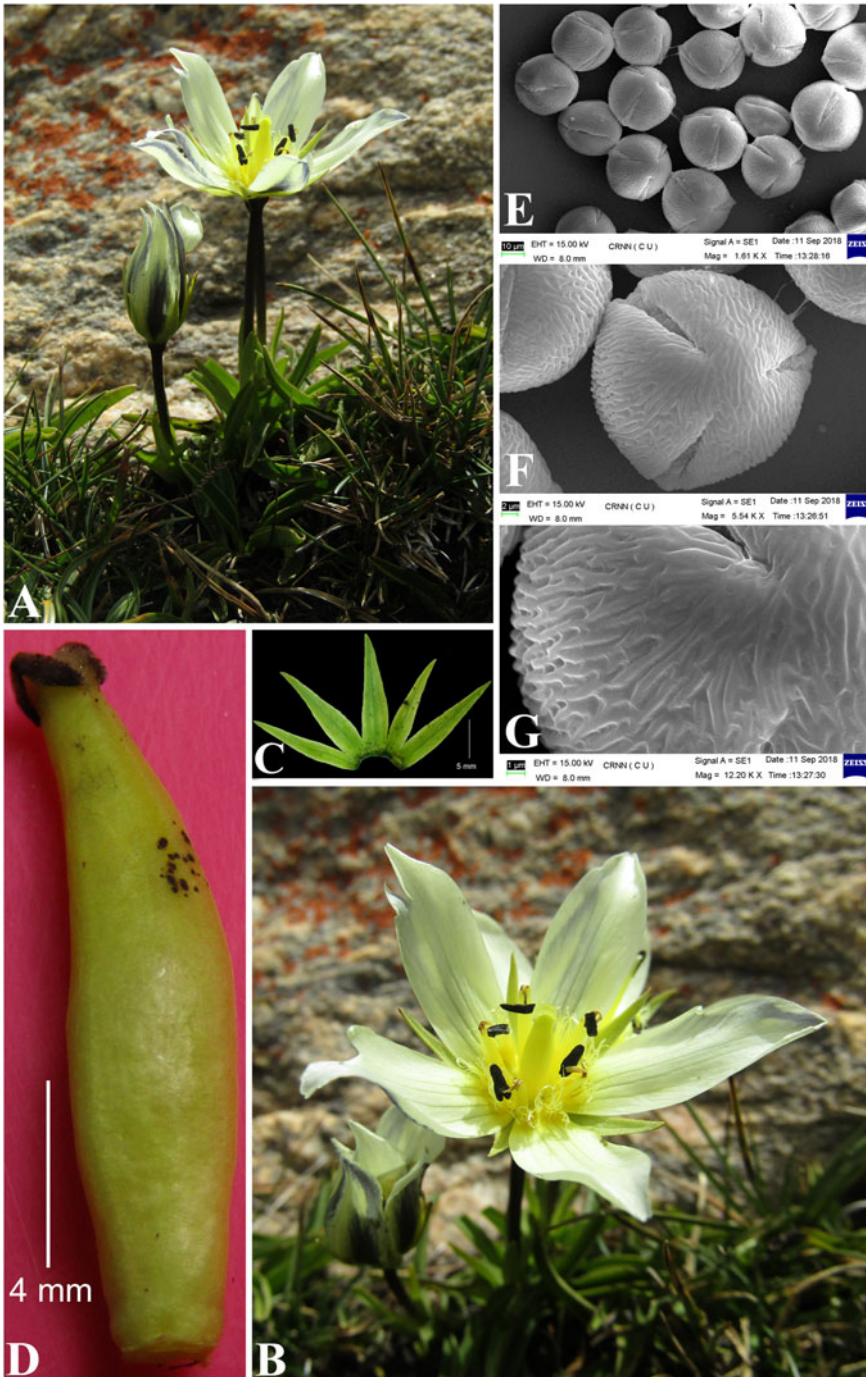


FIG. 2. *Lomatogonium gaurgopalii* sp. nov. A, Habit; B, flower; C, split calyx; D, gynoecium; E–G, pollen grains (E, panoramic view; F, tricolporate pollen grain; G, exine ornamentation) – note striate reticulate nature without perforation.

erect, 5-merous, 4–5 cm in diameter; pedicels 2–5 cm long, glabrous, brownish, striate. *Calyx* tube 1–1.5 mm long, adaxial surface with many rigid hairs around ovary base; lobes unequal, lanceolate, 1.1–1.4 × 0.2–0.3 cm, margin entire, apex acute, 3-veined; midvein rarely branched; laterals usually branched. *Corolla* creamy yellow flushed with bluish violet outside around midvein in basal half and along one margin (overlapping part) in upper half; tube c.2 mm long, with many rigid hairs in an inverted semilunar arrangement behind filament base; lobes slightly unequal, lanceolate-elliptic, 1.9–2.2 × 0.6–0.7 cm, apex sub-acute, entire throughout or finely crenulate near apex. *Nectaries* 2 on each corolla lobe, 6–6.5 mm long, attached c.2 mm above base of corolla; nectary connate at base into a tube, apex lamellate. *Stamens* attached below sinus, c.2 mm above corolla base; filaments 6.5–8 mm long, dilated towards base; anthers blue, narrowly ovoid to oblongoid, 2.2–3 mm long. *Pollen* grains tricolporate, subprolate or prolate-spheroidal; exine striate-reticulate. *Ovary* narrowly ovoid or narrowly ellipsoid, 1.2–1.5 × 0.36 cm. *Ovarian stipe* c.1 mm long; stigma lobes hemispherical, c.1.2 × 1.4 mm, margin recurved at anthesis, ventrally minutely papillate, decurrent to apical part of ovary.

Distribution. Presently known from only three populations in the high Himalayan alpine pastures of north Sikkim, therefore likely to be endemic to Sikkim, India.

Habitat. Plants growing on open alpine pasture between 4400 and 4500 m a.m.s.l. Altogether, several mature individuals as well as young plants were observed. Common associated species include *Aletris pauciflora* (Klotzsch) Hand.-Mazz., *Bistorta affinis* (D. Don) Greene, *Carex* sp. and *Gagea nolitiei* Peruzzi, J.-M. Tison, A. Peterson & J. Peterson.

Flowering. (August to) September (to October).

Proposed IUCN conservation status. *Lomatogonium gaurgopalii* is known only from the type locality. It is currently identified from three populations with some seven or eight mature individuals each, along with several young plants. The area of occupancy and extent of occurrence of the species are < 10 km² and < 100 km², respectively. The locality is highly exposed to anthropogenic threat, including grazing. Considering that the new species is restricted to a small area (c.3 km²) of the Himalayan state of Sikkim and that grazing and other anthropogenic threats may reduce the number of individuals in the future, it is suggested that the species is considered Critically Endangered (CR, B and D) (IUCN Standards and Petitions Subcommittee, 2017).

Etymology. The specific epithet honours Professor Gaurgopal Maiti (retired), University of Kalyani, for his contribution to Gentianaceae.

Additional specimens examined. INDIA. **Sikkim:** before Gurudongmar, about 3.5 km from river, 1 ix 2018, 4400 m, Midday & Ghosh 23834, 23837 (CUH).

A comparison of the major morphological traits of *Lomatogonium gaurgopalii* and *L. cherukurianum* is presented in the [Table](#).

TABLE. Comparison of morphological characters of *Lomatogonium gaurgopalii* sp. nov. and *L. cherukurianum* S.K.Dey & D.Maity

Character	<i>L. cherukurianum</i>	<i>L. gaurgopalii</i> sp. nov.
Habit	Individuals scattered	Individuals in dense clumps
Plant height	3–4(–5) cm	5–12.5 cm
Rhizome	Thin, horizontal, often branched, sheathed by several blackish remains of old petioles below basal leaves	Thick, horizontal, branched, covered with blackish bark throughout length and sheathed by blackish remains of old petioles below basal leaves
Stem	Simple, angular, erect	Simple, angular, erect
Basal leaves		
Shape	Lanceolate, linear-lanceolate or rarely oblanceolate	Lanceolate
Size	1.5–2.6 × 0.2–0.4 cm	1.5–3.5 × 0.3–0.5 cm
Stem leaves		
No. of pairs	1–3	2 or 3
Nature	Sessile to subsessile; lower pair fused at base to c.2.5 mm long sheath; upper pairs sessile, often subamplexicaul	Sessile, basal part always free
Shape	Lanceolate	Lanceolate
Size	0.9–1.5 × 0.2–0.4 cm	1.1–3.5 × 0.2–0.5 cm
Internodes	Shorter than leaves, 0.8–1.2 cm long	Shorter or longer than leaves, 1–2.7 cm long
Flowers	Solitary, terminal, erect, c.2.5 cm in diameter	Solitary, terminal, erect, 4–5 cm in diameter
Pedicels	Green with dull violet, striate, 0.9–1.4 cm long	Glabrous, brownish, striate, 2–5 cm long
Calyx tubes	<1 mm long	1–1.5 mm long
Calyx lobes		
Nature and venation	Unequal, 3-veined; lateral veins often 2 or 3 times branched; margin membranous	Unequal, 3-veined; midvein rarely branched; laterals usually branched, margin not membranous
Shape	Lanceolate to linear-lanceolate	Lanceolate
Size	6–0.8 × 1.5–2.4 mm	1.1–1.4 × 0.2–0.3 cm
Corollas		
Colour	Whitish flushed with blue outside and often with blue lines	Creamy yellow flushed with bluish violet outside around midvein in basal half and bluish violet along one margin (overlapped part) in upper half
Length	1–1.3 cm	2–2.3 cm
Corolla tubes		
Nature	Glabrous	With many hairs in horseshoe-shaped arrangement behind bases of filaments
Length	< 1 mm	c.2 mm

TABLE. (Continued)

Character	<i>L. cherukurianum</i>	<i>L. gaurgopalii</i> sp. nov.
Corolla lobes		
Nature	Slightly unequal	Slightly unequal
Shape	Elliptic, larger one sometimes narrowly obovate, obtuse	Lanceolate-elliptic, subacute
Size	0.9–1.3 × 0.3–0.5 cm	1.9–2.2 × 0.6–0.7 cm
Nectaries		
Position	c.0.5 mm above base of each corolla lobe	c.2 mm above base of each corolla lobe
Length	c.2.5 mm	6–6.5 mm
Filaments	5–6 mm long	6.5–8 mm long
Anthers	Ellipsoid, 2–3 mm long	Narrowly ovoid to oblongoid, 2.2–3 mm long
Ovaries		
Nature and shape	Stalked, ellipsoid	Stalked, narrowly ovoid or narrowly ellipsoid
Size	0.25–0.3 × 0.15 cm	1.2–1.5 × 0.36 cm
Ovarian stipes	Present, 1–1.6 mm long	Present, c.1 mm long
Stigma lobes	Triangular, c.0.5 mm long	Hemispherical, c.1.2 mm long
Pollen		
Shape	Prolate-spheroidal or prolate	Subprolate or prolate-spheroidal
Exine ornamentation	Striate-reticulate with perforations	Striate-reticulate
Flowering time	June and July	(August to) September (to October)

DISCUSSION

Lomatogonium gaurgopalii is a prominent species of the genus, with a dense, clumped growth form and solitary, larger (more than 4 cm in diameter), yellowish terminal flowers. A combination of morphological characters, both vegetative and reproductive, make the new species unparalleled among Himalayan members of the genus.

The uniqueness of the species is reflected in its perennial robust growth habit, long branched rhizome and erect, simple, tall and stout stem. The species seems closely related to the recently described *Lomatogonium cherukurianum* (Dey & Maity, 2017) in its perennial habit, its horizontal branched rhizome sheathed by several blackish remains of old petioles at the base of a simple erect stem, its solitary terminal flower and the nature of its nectary. However, it differs in its taller habit (versus dwarf to 5 cm high, mostly below 4 cm), much longer internodes (versus 0.8–1.2 cm long), larger flower (over 4 cm in diameter versus c.2.5 cm in diameter) with much larger floral parts, and longer pedicel (versus 0.9–1.4 cm long). Notably, the ovary in the new species is significantly larger (1.2–1.5 cm long) than in *Lomatogonium cherukurianum* (0.25–0.3 cm long). The shape of the ovary is also noticeably different (narrowly ovoid or narrowly ellipsoid versus ellipsoid).

The presence of many rigid hairs on the inner surface (adaxial) of the corolla in an inverted semilunar pattern behind the filament base also makes *Lomatogonium gaurgopalii*

distinct from its relative. These hairs are not part of the nectaries. Nectaries are present between stamens, whereas these hairs are found behind the stamen bases and not attached to nectaries.

Importantly, *Lomatogonium cherukurianum* is an early-flowering plant (July) with sporadic individuals mostly on earth hummocks, whereas *L. gaurgopalii* flowers in (August to) September and individuals grow together in dense clumps usually in rock crevices. The type localities of *Lomatogonium gaurgopalii* and *L. cherukurianum*, that is, the lower Gurudongmar valley and the Lhonak valley, respectively, are well separated by high mountains, a few valleys and the Lahonak La pass (c.5500 m a.m.s.l.).

Pollen exine architecture is useful in the taxonomy of the genus, because most of the species have pollen grains with distinct exine ornamentation (Nilsson, 1964; Liu & Ho, 1992; Dey & Maity, 2017). The pollen grains of *Lomatogonium gaurgopalii* have a striate-reticulate exine ornamentation. A total absence of perforations in the exine wall immediately separates the new species from *Lomatogonium cherukurianum*, for which a perforated exine is one of the major diagnostic traits (Dey & Maity, 2017).

The new species has some similarity with *Lomatogonium stapfii* (Burkill) Harry Sm. in its perennial habit, horizontal branched rhizome sheathed by blackish remains of old petioles at the stem base, and simple stem with a solitary terminal flower. However, other attributes of *Lomatogonium stapfii*, such as its spatulate to obovate basal leaves, general absence of stem leaves, smaller, pale blue nodding flower, spatulate to obovate calyx lobes, broadly obovate corolla lobes and minutely verrucate exine sculpture (Liu & Ho, 1992) clearly distinguish it from the new species.

More detailed studies of the actual distribution and status of populations of this species are required. Based on the present state of knowledge, the immediate attention of the relevant authorities is needed to protect this magnificent species through suitable conservation measures.

A key for *Lomatogonium gaurgopalii* and the most similar species, namely *L. cherukurianum*, *L. longifolium* and *L. stapfii*, is provided to facilitate correct identification.

Key to *Lomatogonium gaurgopalii* and similar species

- 1a. Leaves spatulate to obovate or spatulate to oblong; flower solitary or several _____ 2
- 1b. Leaves mostly lanceolate; flower solitary _____ 3
- 2a. Flower solitary, nodding _____ *L. stapfii*
- 2b. Flowers several in raceme-like inflorescence, erect _____ *L. longifolium*
- 3a. Flower smaller, around 2.5 cm in diameter; ovary less than 0.5 cm long
_____ *L. cherukurianum*
- 3b. Flower larger, 4–5 cm in diameter; ovary more than 1 cm long _____ **L. gaurgopalii**

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