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### NOTE

***GENTIANA SAGINOIDES* BURKILL (MAGNOLIOPSIDA: GENTIANALES: GENTIANACEAE) REDISCOVERED FROM SUNDERDHUNGA VALLEY IN UTTARAKHAND 155 YEARS AFTER DESCRIPTION: NOTES ON ITS POPULATION STATUS**

Dharmendra S. Rawat, Charan S. Rana, Harish Singh & Manish Karnatak

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Many narrow endemic species in the Himalaya are known only by the type collections and, if not collected again for a century, are generally considered extinct. *Gentiana saginoides* Burkill (Gentianaceae) is one such point endemic (Agrawal 1982; Garg 1988) in Kumaun Himalaya. A field visit was conducted during June 2012 in Sunderdhunga Valley of Bageshwar District in Kumaun (Fig. 1) to re-locate its populations. This alpine valley (Image 1D) is adjacent to Pindari glacier and carries the melted waters of the Mrigthuni, Mangtoli and Sunderdhunga glaciers located at the southern boundary of the core zone of the Nanda Devi Biosphere Reserve. A total of 72km were trekked during this exploration which included about 30km in and around the type locality of *Gentiana saginoides* along the trek route.

**Materials and Methods:** Species of *Gentiana* L. were identified in the field using descriptions, keys and line diagrams of Garg (1987) and one taxon resembling *G. saginoides* was also noticed and collected. *Gentiana argentea* (D. Don) Griseb and *G. capitata* Buch.-Ham. ex D. Don were also seen in the area. Considering the extremely rare nature of the species, only a few specimens were collected. The flowering individuals (mature individuals) were counted in 1m<sup>2</sup> areas at few places in site-1 and 2, separately, and the numbers were multiplied by approximate area of sites to obtain range of number of individuals in one site. The specimens were processed as per the standard herbarium procedure (Jain & Rao 1976) and one sheet each was deposited in CAL

## **GENTIANA SAGINOIDES BURKILL (MAGNOLIOPSIDA: GENTIANALES: GENTIANACEAE) REDISCOVERED FROM SUNDERDHUNGA VALLEY IN UTTARAKHAND 155 YEARS AFTER DESCRIPTION: NOTES ON ITS POPULATION STATUS**

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and BSD and the rest were housed at G.B. Pant University Herbarium in Pantnagar. Morphological features of the species were studied under a dissecting microscope and the description was prepared by studying all the collected specimens.

**Results:** The identity of *Gentiana saginoides* was confirmed after thorough checking with the published descriptions and diagrams (Agrawal 1982; Garg 1987), protologue (Burkill 1906) as well as by comparison with type (T. Anderson *s.n.* Acc. No. CAL-300119!) at CAL. Individuals of the herb *G. saginoides* were found growing on moist, steep, exposed slopes in treeline ecotone areas (zone of transition between uppermost montane forest

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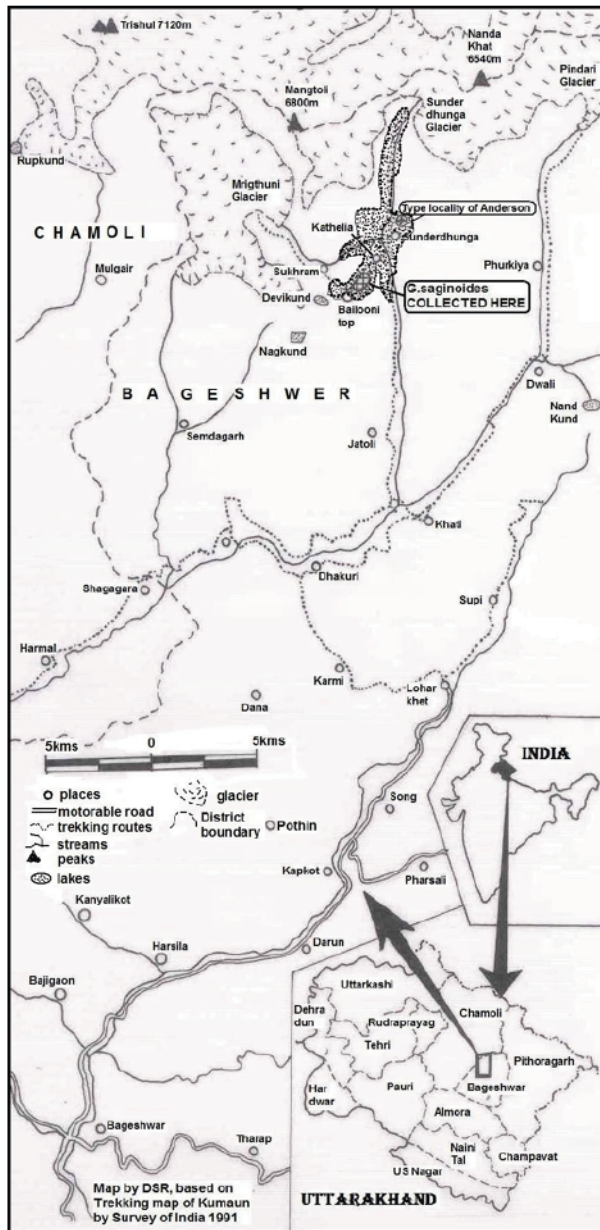


Figure 1. Location map of Sunderdhunga area, type locality, surveyed area (shaded) and rediscovery sites

Table 1. Systematic position of *Gentiana saginoides* Burkill as per APG-IV (2016) classification

Informal group	Angiosperms
Informal group	Eudicots
Informal group	Core Eudicots
Informal group	Superasterids
Informal group	Asterids
Informal group	Lamiids
Order	Gentianales Juss. ex Bercht. & J.Presl
Family	Gentianaceae Juss.
Genus	<i>Gentiana</i> L.
Species	<i>G. saginoides</i> Burkill

and alpine meadows) at two locations (Table 2). The first location at 3,470m elevation had a small population of approximately 60–80 mature individuals. The second location was an open area among the *Rhododendron campanulatum* D.Don shrubs at 3,686m elevation (Image 1C). In this location a relatively larger population of 3,000–3,600 mature individuals was recorded.

**Gentiana saginoides**

Burkill in *J. & Proc. Asiat. Soc. Bengal* 2(7): 318. 1906; Garg, *Gentianaceae Northwest Himal. Rev.* 167. 1988.

(Table 1, Image 1B, Fig. 2A–I)

Annual herbs, 2–4 cm tall, erect to decumbent, branched, glabrous; branches up to 2cm long. Radical leaves 1–2 pairs, sessile, narrowly ovate, 5–7 x 3–4 mm, acuminate at apex, with up to 1 mm long acumen, rounded at base, narrowly cartilaginous along margins, indurate; nerves 3, mid-nerve prominent, lateral subapically evanescent. Cauline leaves sessile, basally connate, basal sheath up to 1mm long, conduplicate, longer than internode, erect (not spreading), crowded below flower, linear-oblancoelate, 3–7 x 1–1.5 mm, acuminate at apex with a pointed tip. Flowers solitary, terminal on each decumbent branch, pale blue, sessile, 5-merous, infundibuliform, 5–6 mm long. Calyx slightly smaller than corolla, 5–5.5 mm long, tube 2–3 mm long, subcarinate, persistent, lobes linear lanceolate, acuminate, 2.5 x 0.5 mm, 3 nerved, margins narrowly cartilaginous, indurate, sinuses acute, apices aristate. Corolla infundibuliform, 5.5–6.5 mm long; tube 3–5 mm long; lobes ovate-lanceolate, 1.5 x 1 mm, acuminate, pale blue within, greenish without; plicae triangular, almost equal to corolla lobes, slightly bidentate. Stamens 5, included in corolla tube, inserted in the middle of corolla tube, unequal, 3 slightly longer, 1–1.5 mm long; anthers oblong-ovate, ca 0.25 mm long, yellow; filaments filiform. Ovary oblong-elliptic, 2–3 x 2 mm, stipitate; style slender, ca. 1 mm long; stigma 2-lobed, papillose, revolute later. Capsules obovate, crestate, 3–4 x 3 mm, protrudes out from corolla tube at dehiscence. Seeds numerous, elliptic, ca. 0.75 x 0.5 mm; testa reticulate, light brown.

Specimens examined: Acc. no-300119, (Holotype CAL!), India, Uttarakhand, Kumaon, Soonderdunga (Sunderdhunga), 10,000ft (3,000 m), May 1857, coll. T. Anderson; Acc. no-446, G.B. Pant University Herbarium Pantnagar !, (Image-1A), India, 19.vi.2012, West Himalaya, Uttarakhand, Bageshwar District, Sunderdhunga Valley, on way to Bailooni top, 3470m, coll. D.S. Rawat; Acc. no-447, G.B. Pant University Herbarium Pantnagar!, 19.vi.2012, West Himalaya,



Image 1. *Gentiana saginoides*.

A - specimens from the present collection; B - live specimen from site 2; C - site-2 (3,686m) of present collection; D - a view of Sunderdhunga Valley, (probable type locality indicated by white rectangle)

Uttarakhand, Bageshwar District, Sunderdhunga Valley, on way to Bailooni top, 3686m, coll. D.S. Rawat.

Flowering: May–June

Fruiting: June

Habitat: Open slopes around timberline, 3,000–3,686 m above sea level. Growing with *Anaphalis* sp., *Carex* sp., *Fragaria nubicola* (Lindl. ex Hook.f.) Lacaite, *Geranium* sp., *Potentilla atrosanguinea* G.Lodd. ex D.Don, *Primula denticulata* Sm., *Ranunculus hirtellus* Royle, *Sibbaldia parviflora* Willd., *Trachydium roylei* Lindl., *Viola biflora* L., and mosses.

Distribution: Endemic to Sunderdhunga Valley (30°13'N & 79°54'E; 3000–3686m) in Bageshwar District of Uttarakhand State, India.

**Discussions:** This species was assessed as 'rare' by Rao et al. (2003) and Uniyal et al. (2007) based on a review of rare gentians by Agrawal (1983) as nothing was known about it after type collection in 1857. Based on the recent collections and field observations given below, we assess the threat status of *G. saginoides* as 'Critically Endangered' by following IUCN (2001) Red List Categories and Criteria (ver. 3.1):

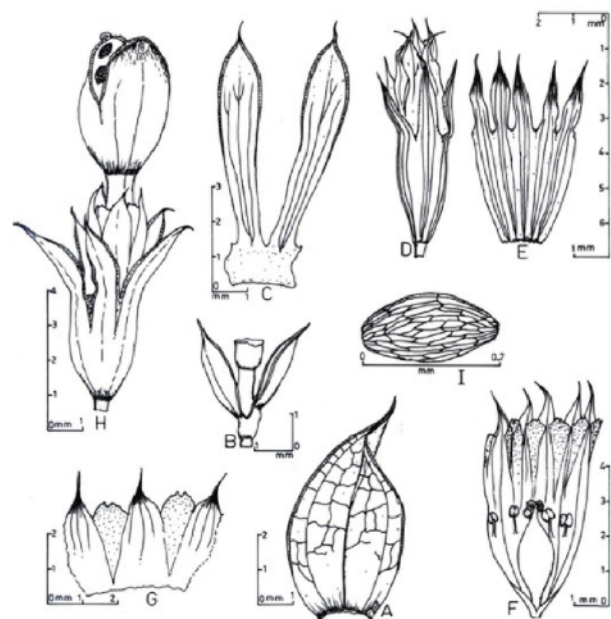


Figure 2. *Gentiana saginoides* Burkill

A - basal leaf; B - pair of leaves on the branch; C - pair of stem leaves with basal sheath; D - flower, E - calyx split open; F - corolla split open to show stamens and carpel; G - corolla lobes and interlobal plicae; H - capsule protruding out of flower; I - seed.

1. The existing information (in type specimen and literature) has indicated that the species is a point endemic in Sunderdhunga at the elevation of 10,000 feet (3,000m). Obviously, the maximum chances of finding this species lie at and around this locality and elevation. Thus the area in the elevation range of 3,000 m- 3,700 m along the trekking route which covers approximately 15-20 km<sup>2</sup> (shaded area in Fig.1) was targeted. It was believed that the trekking of 30 km in and around the type locality and survey of 15-20 km<sup>2</sup> area for this species was appropriate for a point endemic. The extent of occurrence (geographical area) is less than 5km<sup>2</sup> based on our survey including the type locality. The two populations recorded during our exploration together cover less than 250m<sup>2</sup> and the area of occupancy is very small. Thus the species qualifies under B1a, c (i, ii) and B2a, c (i, iii) of the IUCN (2001) guidelines.

2. In the type locality (Sunderdhunga) and adjacent areas, the species was not found in spite of careful observation of ground vegetation.

3. The species thrives in specific habitat conditions. Small prostrate stature and annual nature of species requires open areas for flowering and seed development in the early season as it has to produce seeds before other species overshadow it after their vegetative growth following snow melt. The species was neither recorded

**Table 2. Location, individuals/m<sup>2</sup> and associated species in different sites.**

Site; approx. area	Geo-coordinates	Plants /m <sup>2</sup>	Associated species	Surrounding trees/ krumholtz
Anderson' site (probable type locality) Alpine rocks; <1km <sup>2</sup>	Elevation "10,000 ft" (3,000m)	Information not available		
Site-1 steep exposed slope; <10m <sup>2</sup>	30°13'17.2"N & 79°54'52.6"E Elevation 3,470m	6–8	<i>Carex</i> sp., <i>Fragaria nubicola</i> (Lindl. ex Hook.f.) Lacaïta, <i>Galium</i> sp., <i>Koenigia nummularifolia</i> (Meissn.) Hedberg, <i>Potentilla atosanguinea</i> G. Lodd. ex D. Don, <i>Viola biflora</i> L., and mosses	<i>Betula utilis</i> D. Don, <i>Prunus cornuta</i> (Wall. ex Royle) Steud., <i>Sorbus foliolosa</i> (Wall.) Spach
Site-2 steep exposed slope; ca. 200m <sup>2</sup> (Image 1C)	30°13'1.5"N & 79°54'46.2"E Elevation 3,686m	15–18	<i>Anaphalis</i> sp., <i>Bistorta macrophylla</i> , <i>Carex</i> sp., <i>Fragaria nubicola</i> (Lindl. ex Hook.f.) Lacaïta, <i>Geranium</i> sp., <i>Potentilla atosanguinea</i> G. Lodd. ex D. Don, <i>Primula denticulata</i> Sm., <i>Ranunculus hirtellus</i> Royle, <i>Rumex nepalensis</i> Spreng., <i>Sibbaldia parviflora</i> Willd., <i>Trachydium roylei</i> Lindl., <i>Viola biflora</i> L.	<i>Rhododendron campanulatum</i> D. Don

in shady conditions inside treeline ecotone forest stands nor seen in alpine meadows above the treeline in the entire area surveyed (15-20 km<sup>2</sup>).

4. The estimated number of mature individuals was <5000 (3,060–3,680, Table 2).

5. The habitats recorded in the present study are in the treeline ecotone areas which are sensitive to recent climate change and any amelioration here may wipe out the only surviving populations. Recent studies like Bharti et al. (2011), Singh et al. (2012) have unambiguously demonstrated that the timberline vegetation is moving upwards and ecotone areas are being occupied with new tree recruits in Uttarakhand Himalaya. If it happens so in the areas of the only known populations of *G. saginoides* the species will not be able to survive under the shades of trees as it requires open areas for growth.

The apparent reasons of complete absence of species from the type locality could be:

1) Inability of species to compete with firmly rooted perennial species occurring in the area. Since *G. saginoides* is very small annual it needs open spaces each year to complete its life cycle. Moreover, annual mode of life is less successful in sub alpine and alpine zones (Korner 1999).

2) Occasional burning of dried grasses (especially *Tenaxia cachemyriana* (Jaub. & Spach) N.P. Barker & H.P. Linder) by herdsmen during the early season (May–June) may harm the plants or seeds of *G. saginoides* which attain the flowering and seed dispersal stages in this duration (Image 2).

Dhar (2002) has proposed a 1–8 cell classification of endemic species based on geographical range of distribution, ecological amplitude and anthropogenic pressure on them. The species included in the 8<sup>th</sup> cell requires highest priority for conservation and this priority reduces with the decreasing number of the cell. In this classification, *Gentiana saginoides* falls in



**Image 2. A burnt alpine slope in June with burnt tussocks of *Tenaxia cachemyriana*. Such burning in May-June is one of the potential threat to *Gentiana saginoides***

the 8<sup>th</sup> category (restricted geographical range, narrow ecological amplitude and high anthropogenic pressure) and thus deserves a high priority for conservation.

The present collection of *Gentiana saginoides* is an example of rediscoveries after a long lapse from the type collections. This, along with other recent re-collections of the endemics of Uttarakhand such as *Arenaria curvifolia* Majumdar (Rawat & Rana 2007), *Gentiana tetrasepala* Biswas (Rawat 2009), *Dipcadi reidii* Deb and S. Dasgupta (Rawat & Chandra 2014), support our claim that more efforts in plant explorations are required in the remote Himalayan terrain. Therefore, considering its Critically Endangered status and location in 8<sup>th</sup> cell, this species warrants immediate *in situ* as well as *ex situ* conservation measures. In near future focussed field explorations are also needed to monitor the surviving populations.

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