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Contribution to the Flora of Dihang-Dibang Biosphere Reserve, India-II

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ABSTRACT: The Dihang–Dibang Biosphere Reserve (DDBR), one of India's important protected areas, was designated as a Biosphere Reserve and comprises distinct core and buffer zones. To document its phytodiversity, eighteen extensive field expeditions were conducted across different habitats. Detailed taxonomic examination of the collected specimens revealed several noteworthy findings, including novel taxa, endemic species, unique habitat preferences, and new distributional records. This paper presents significant observations on members of the family Gentianaceae recorded from the DDBR. The study includes the description of two new species, *Kuepferia dibangensis* Bhaumik & G. Krishna and *Swertia dihangensis* Bhaumik & G. Krishna, as well as the first report of *Kuepferia otophoroides* (Harry Sm.) Adr. Favre from India. Although these taxa occur within a protected landscape, their conservation status was assessed following IUCN guidelines. Detailed taxonomic descriptions, illustrations, photographic plates, and habitat information are provided to facilitate future research and conservation efforts.

KEY WORDS: Conservation, Gentianaceae, *Kuepferia otophoroides*, India, new species, *Swertia*, taxonomy.

INTRODUCTION

Dihang-Dibang Biosphere Reserve (here after, DDBR), one of India's protected areas, was declared a biosphere reserve on 2 September 1998, with a total area of 5111.5 Sq. Km. in the state of Arunachal Pradesh. Out of this 4094.80 Sq. Km. from the core zone and remaining 1016.70 Sq. Km. from the buffer zone. The varied topography and altitudinal range from 500 m to over 6000 m, harbours unique flora and fauna. Due to inaccessibility of the area, plant diversity has been poorly studied (Mudgal *et al* 2002; Bhaumik, 2014, Bhaumik and Krishna, 2024).

The tribe *Gentianeae* Colla., composed of the subtribes *Gentianinae* G. Don and *Swertiinae* (Griseb.) Rchb., represents the most species-rich lineage within the Gentianaceae. The two subtribes can be readily distinguished by morphological characters. The members of *Gentianinae* possess basal ovarian glands and typically show plicae-folds between the corolla lobes. In contrast, species in *Swertiinae* feature epipetalous glands and lack plicae entirely. Multiple phylogenetic analyses have provided strong support for the monophyly of each subtribe (Yuan and Kuepfer, 1995; Struwe *et al*., 2002; Favre *et al*., 2010, 2014). Favre established the new genus *Kuepferia* based on morphology and DNA analysis (Favre *et al*., 2014). The genus is characterised by corolla lobes equal to or longer than the tube, plicae reduced to auricles, margin entire, stamens equal, straight and seeds neither triquetrous nor compressed. This genus is represented by 14 species and distributed in the Himalayas to south central China (POWO, 2025).

Based on above morphological characters one of our collections belongs to the genus *Kuepferia* Adr. Favre. After thorough micro-morphological studies, an elaborate taxonomic description and illustrations have been prepared. Comparison with all described species of *Kuepferia* (Ho, 1984; Ho and Liu, 1990; Ho and Pringle, 1995; Struwe *et al*., 2002; Gupta *et al*., 2022) showed that the specimens did not match any known species; they are therefore described and illustrated here as a new species.

The subtribe *Swertiinae* (Griseb.) Rchb. comprises 15 genera, of which *Swertia* L. is one of the largest among them (Struwe and Pringle, 2018). The genus *Swertia* L. contains about 166 accepted species (POWO, 2025) distributed from subarctic and subalpine regions of the Northern Hemisphere to tropical mountains of the Old World. All the species are categorized under 16 series and 11 sections (Ho *et al*., 1994) and the highest concentration of taxa is found in Sino-Himalayan region. To look into the phylogenetic relationship among taxa with modern molecular analysis with limited data, initially it was found that the genus *Swertia* L. is paraphyletic (Chassot *et al*., 2001), but, more molecular data established it as a monophyletic group (Xi, *et al*., 2014).

The proposed new species of *Swertia* L., characterized by perennial, multi-stem, scapiform habit, tetramerous flower, solitary nectary places it in section *Poephila* (C.B. Clarke) Gilg. The section represented by 4 species only (Ho and Pringle, 1995; Ho and Liu, 2015) and the members are distributed in Sino-Himalayan region only.

While studying with the floral diversity of the area several new descriptions have already been published viz. Bhaumik (2014); Bhaumik and Krishna (2024) and others. In continuation of this work, two new species and one new distributional record belonging to the family Gentianaceae are proposed here.

MATERIALS AND METHODS

To document the phyto-diversity of DDBR, intensive and extensive field surveys were undertaken periodically in various flowering and fruiting seasons to different habitats during 1995–2015. A total of eighteen field explorations were conducted and over 15,000 specimens were collected. The duration of each field survey ranged between 28 and 60 days. The specimens were dried, processed and mounted following conventional methods (Jain and Rao, 1977).

After a comprehensive review of the relevant literature, including works by Don (1837), Clarke (1883), Burkill (1906), Rao and Joseph (1965), Smith (1970), Geesink (1973), Ho and Liu (1980), Shah (1990 and 1992), Wang and Lu (1998), Aitken (1999), Choudhary (2008), Nampy *et al*. (2015), and Gupta *et al*. (2022), as well as consultations with physical herbaria such as CAL, BSHC, ARUN, ASSAM, BSD, DD, and digital resources like the K, E, PE Herbaria, the Chinese Virtual Herbarium (CVH), and GBIF, we concluded that two of the collected taxa represent undescribed species. Detailed descriptions and illustrations of this species are provided below. A comparative analysis is also included in Tables 1 and 2, highlighting the traits of its closest relatives.

TAXONOMIC TREATMENT

Kuepferia dibangensis Bhaumik & G. Krishna, ***sp. nov.***
Figs. 1 & S1

Type: Upper Siang, Pavo to Psonga (28°58'N; 95°14'E) & Teetapuri (28°57'N; 95°14'E), 3700–4500m, 07.08.2012, *Pathak & G. Krishna 56523* (Psonga, Teetapuri) (***Holotype***: CAL, Barcode no. CAL0000330015; ***Isotypes***: CAL, Barcode no. CAL0000330016, BSIS); Upper Siang Pemashree proper, 4000–4500m, 12.09.2011, *Pathak & G. Krishna 54333* (***Paratype***: CAL Barcode no. CAL0000330017, BSIS).

Diagnosis: This new species is close to *Kuepferia doxiongshangensis* (T.N. Ho) Adr. Favre, but differs from it in smaller sessile leaf blade 5–7 mm long, bases sheathing encircling the stem (vs. 1–2.5 cm), margin entire not scabrous, vein 1–3(–5) (vs. 1); flowers mostly sessile or 1.5–2 mm long pedicelled (vs. 1–2 cm long pedicelled); capsules oblong to 2.1 cm long (vs. narrowly ellipsoid 1.3–1.5 cm long); seeds falcate to oblong-elliptic, 1.5–1.8 mm longitudinally striate reticulate (vs. brown ellipsoid c. 1 mm, coat alveolate).

Description: Annual, erect or decumbent glabrous herb, 7–15 cm high. Stem usually solitary, rarely branched once near the base. Basal leaves 3–11, sub rosette whorled by 2–3 leaves, congested above base; blade sub-coriaceous, elliptic-oblong to ovate, 5–7 × 1–2 mm, apex rounded, 1–3(–5)-veined, midvain keeled, margins hyaline, base sheathing encircling the stem. Upper cauline leaves 4–7 pairs, opposite, smaller but similar to basal leaves 3–6 × 1–1.5 mm. Inflorescence terminal, one-flowered, rarely two-flowered; pedicel reduced, 1.5–2 mm or absent, concealed by upper pair of leaves. Flower uniformly blue or pinkish blue, 5-merous 1.5–2.5 cm long. Calyx tubular campanulate 5–7 mm long including lobe; lobes subulate to linear-acicular, 1.5–2 mm, apex rounded. Corolla tubular 1.2–2 cm long, lobes 5, ovate 2–3 × c. 2 mm, rounded at apex, plicae entire, reduced, auriculate, c. 1 mm long. Stamens 5, equal, attached below middle of the corolla tube; filaments c. 8 mm long, gradually flattened towards base; anther yellow ca.1.2 mm long. Ovary oblong-elliptic, c. 18 × 2 mm long; style absent; stigma 2, linear, curved c.1 mm long. Capsules oblong, 1.8–2.1 × 1–1.2 cm abruptly rounded at apex, narrowed towards base; gynophore 5 mm long, gland encircled on gynophore. Seed falcate to oblong-elliptic, 1.5–1.8 × c. 0.5 mm, dark blackish-brown, longitudinally striated-reticulated.

Flowering & Fruiting: July–September.

Etymology: The specific epithet of the new species derives from place of occurrence, i.e. Dihang-Dibang Biosphere Reserve.

Conservation Status: The new species are growing in a conserved site and far away from human habitation. About 100 mature individuals scatteredly distributed in an open mountain top within one sq. km area. As per present state of knowledge, it would be may categorized as Data Deficient (DD) (IUCN, 2025).

Swertia dihangensis Bhaumik & G. Krishna, ***sp. nov.***
Figs 2 & S2

Type: Upper Siang, Pavo, Psonga (28°58'N; 95°14'E) to Teetapuri (28°57'N; 95°14'E), 3700–4500m, 07.08.2012, *Pathak & G. Krishna 56503* (***Holotype***: CAL, Barcode no. CAL0000330013, ***isotype***: CAL, CAL0000330014, BSIS).

Diagnosis: The new species closer to *Swertia handeliana*, *S. conaensis* and *S. scapiformis* based on its apparent morphology, but differ by larger habit, 15–30 cm tall (vs. less than 10 cm); broader basal leaf blade 1–1.2 cm (vs. less than 6 mm wide); scape many, 10–40 flowers per scape (vs. solitary flowered); flowers smaller, c. 5 mm diameter (vs. larger, more than 1 cm diameter); nectaries ovate, emarginate at apex, naked spot like without fimbriae (vs. spathulate to elliptic with or without fimbriae).

Description: Perennial, erect, caespitose herb, 15–30 cm high; rhizome short, stout knotty, taproot cylindrical. Stem ascending, many, scapiform, simple quadrangular, glabrous. Basal leaf blade membranous, elliptic-spathulate, 2–3 × 1–1.2 cm, apex acute, 3–5-veined, base narrowed into a petiole up to 3.2 cm long; scape leaves 2–3 pairs, broadly elliptic-ovate, 2–3 × 1–1.5 cm, apex acute, 3–5-veined; sessile, gradually smaller towards apex. Inflorescence cymose, terminal and upper axils. Each axil bears 1–3(–5) flowers. Calyx tubular campanulate; tube 1–1.3 mm; lobes 4, lanceolate, 1.5–2 × 1–1.2 mm, acute. Corolla blue, campanulate, 4-merous, c. 5 mm across; tube

Table 1. Comparison of diagnostic characters **of *Kuepferia dibangensis*** and ***Kuepferia doxiongshangensis***.

	Kuepferia dibangensis	***Kuepferia doxiongshangensis***
Habit	annual, 7–15 cm high	Perennial, 5–10 cm high
Basal leaves	3–11; blade sub-coriaceous, elliptic-oblong to ovate, 5–7 × 1–2 mm, 1–3(–5)-veined	2–5; blade membranous, narrowly elliptic, 1–2.5 cm × 2.5–4.5 mm; 1-veined
Upper cauline leaves	4–7 pairs; sessile; blade elliptic-oblong to ovate, 3–6 × 1–1.5 mm	3–5 pairs; petiole 3–5 mm; blade elliptic to ovate-elliptic, 7–11 × 3–4.5 mm
pedicel	reduced, 1.5–2 mm or absent	distinct, (0.5–)1–2 cm
Calyx lobes	subulate to linear-acicular, 1.5–2 mm	linear-lanceolate, 2–2.5 mm
Corolla lobes	2–3 mm long	4–4.5 mm long
Capsule	oblong, 1.8–2.1 cm; gynophore c. 5 mm	narrowly ellipsoid, 1.3–1.5 cm; gynophore 6–7 mm.
Seed	falcate to oblong-elliptic, 1.5–1.8 mm, longitudinally striated-reticulated	ellipsoid, 0.8–1 mm; seed coat alveolate

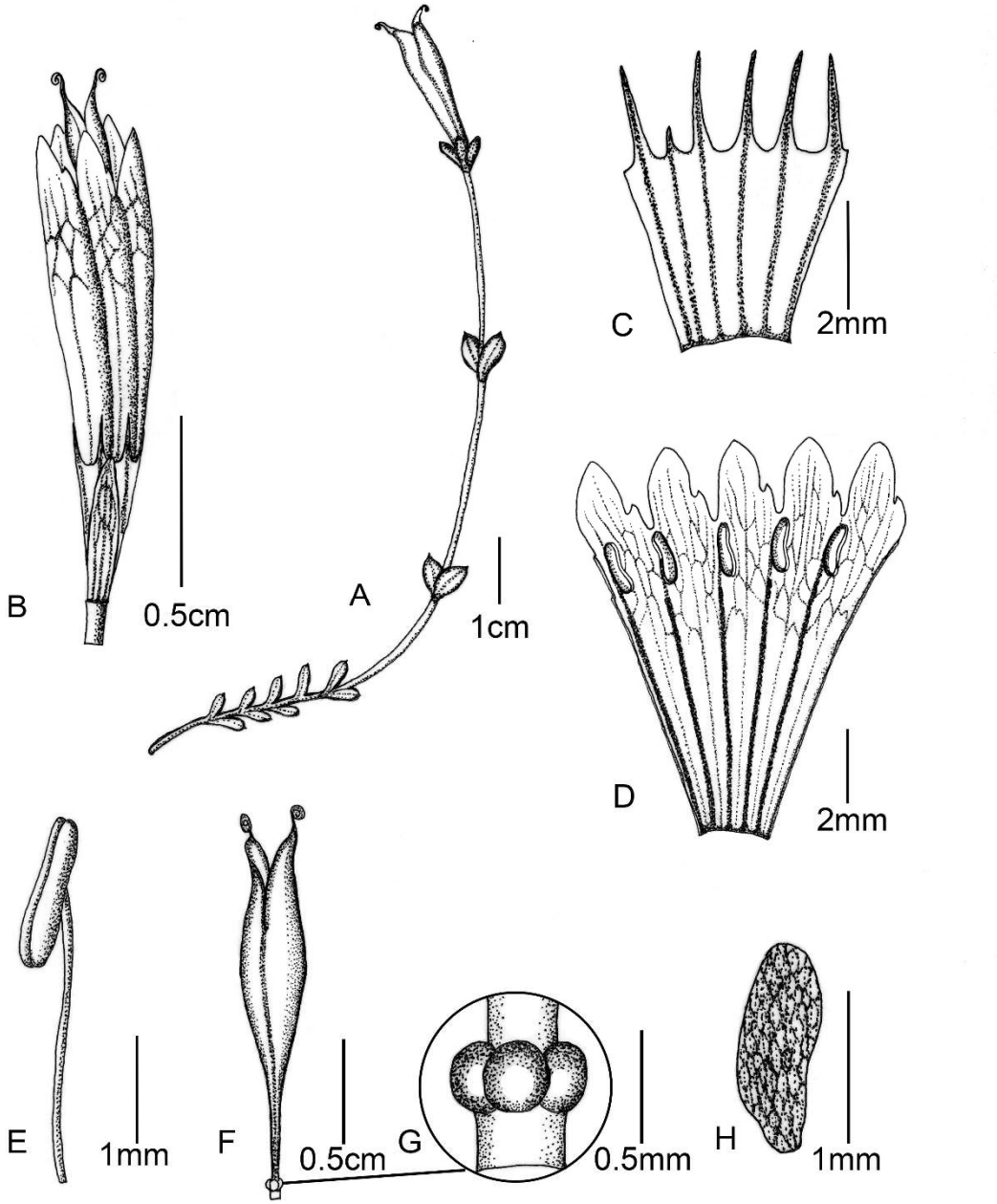

Fig. 1. ***Kuepferia dibangensis*** Bhaumik & G. Krishna **A.** Habit **B.** Flower **C.** Calyx split open **D.** Corolla spilt open **E.** Stamen **F.** Fruit **G.** Gland (Close up) **H.** Seed. Drawn by Priyanka Bhandari from *M.K.Pathak & G. Krishna 56523* CAL!.

Table 2. Comparison of diagnostic characters among ***Swertia dihangensis***, ***S. handeliana***, ***S. conaensis*** and ***S. scapiformis***

Characters	*Swertia dihangensis*	*Swertia handeliana*	*Swertia conaensis*	*Swertia scapiformis*
Habit	15–30 cm high	2–4 cm high	5–7 cm high	5–7 cm high
Basal leaf blade	elliptic-spathulate, 1–1.2 cm wide, glabrous	ovate to suborbicular, 3–5.5 mm wide, glabrous	narrowly elliptic-spathulate, 3–5 mm wide, loosely pubescent on both sides	narrowly elliptic-spathulate, 3–5 mm wide, margin densely papillose
Scape	many, glabrous. Flowers 10–40 in each scape	few, glabrous. Flower solitary, Terminal on each scape.	numerous, glabrous or pubescent. Flowers solitary on naked scape	numerous, angles densely papilose. Flowers solitary terminal in each scape
Flowers	c. 5 mm diameter	8–10 mm diameter	1.2–1.4 cm diameter	1.5–2.2 cm diameter
Calyx lobes	lanceolate, 1.5–2 mm, apex acute, margin glabrous	ovate-lanceolate to ovate-elliptic, 3.5–4.5 mm, apex obtuse, margin scabrous	narrowly oblong, 8– 10 mm long, apex obtuse, pubescent on both sides	elliptic-spatulate, 8–11 mm, apex obtuse and with a recurved tip, margin densely papilose
Corolla	6–7.5 mm, lobes ovate-oblong, apex rounded	8–10 mm, lobes oblong, apex obtuse and mucronate	9–10 mm, lobes eroded at apex, densely pubescent on both sides	10–13 mm, lobes oblong, apex emarginate
Nectaries 1 per corolla lobe	naked, spot like, broadly ovate, emarginate at apex, without fimbriae	reduced to a flat gland patch without raised margin or fimbriae	orbicular, reduced to a gland patch without raised margin or fimbriae	rhomboid, margin raised and with inflexed stiff fimbriae

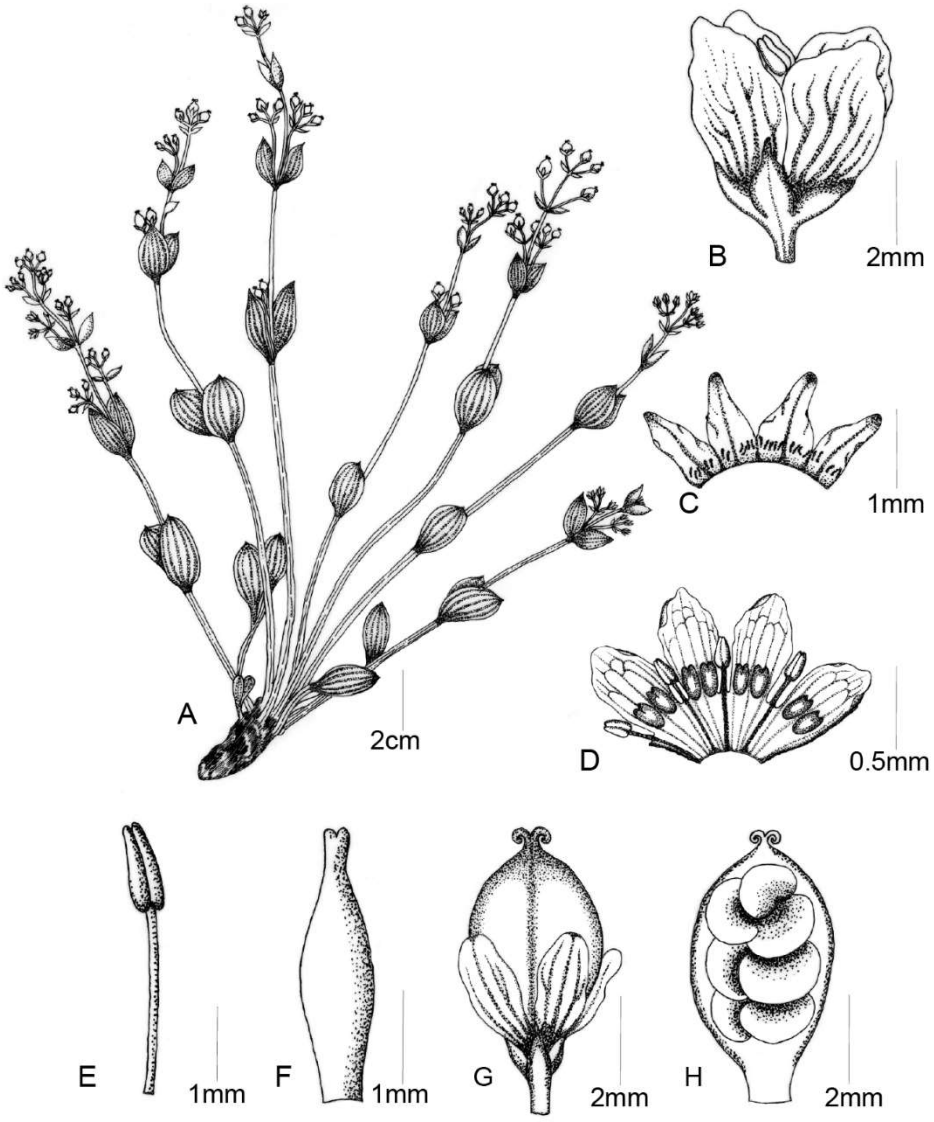

Fig. 2. ***Swertia dihangensis*** Bhaumik & G. Krishna **A.** Habit; **B.** Flower; **C.** Calyx split open; **D.** Corolla split open; **E.** Stamen; **F.** Ovary; **G.** Capsule; **H.** Seeds Drawn by Priyanka Bhandari from *M.K. Pathak & G. Krishna 56503*, CAL!.

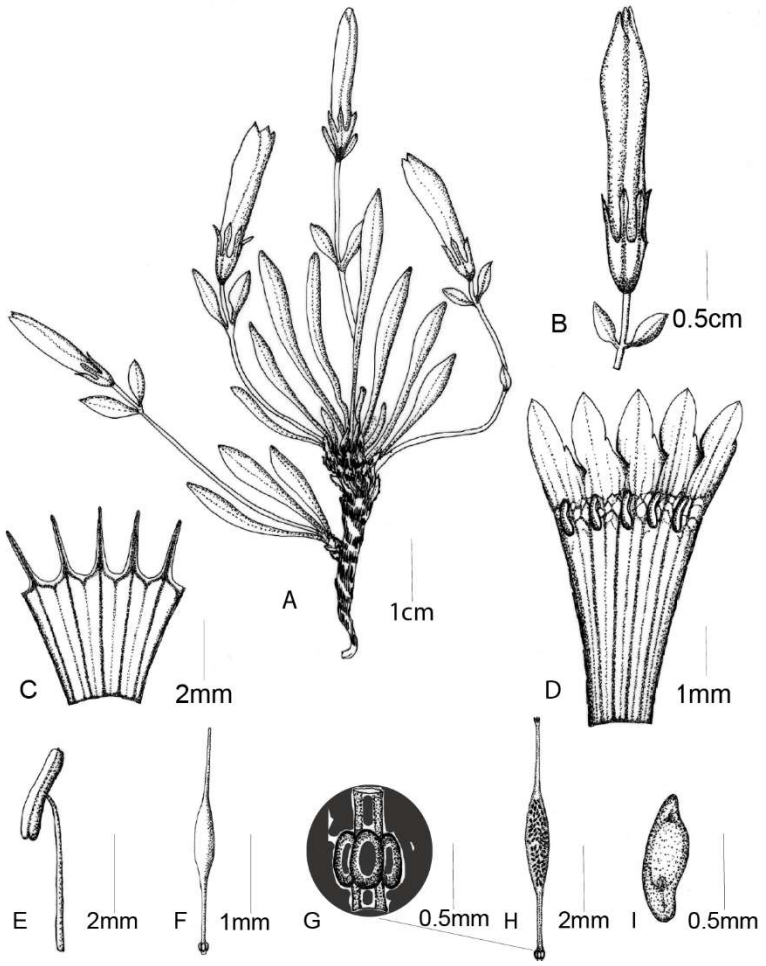

Fig. 3. ***Kuepferia otophoroides*** (Harry Sm.) Adr. Favre: **A.** Habit **B.** Flower **C.** Calyx split open **D.** Corolla split open **E.** Stamen **F.** Gynoecium **G.** Gland (Close up) **H.** Fruit **I.** Seed. Drawn by Priyanka Bhandari from *M.K. Pathak & G. Krishna 56520*, CAL!

2–2.5 mm long; lobes ovate-oblong, 4–5 × 3–3.5 mm, rounded at apex 5(–7)-veined. Gland solitary at base of each corolla lobe, naked, spot like, rounded, not fimbriate. Stamens 4, attached at the base of corolla tube, free from joints of corolla lobe; filament 2–2.5 mm; anther 1–1.5 mm. Ovary ellipsoid, 1–1.5 × 0.8–1 mm; style c. 0.5 mm long; stigma 2-lobed, short echinate. Capsules ellipsoid to broadly-ovate, 6–9 × 4–5 mm; stigma persistent, shortly 2-lobed, echinate. Seeds flat brownish, obovoid to orbicular, 0.8–1.5 × 0.6–0.8 mm, rounded at apex, surface roughened.

Flowering & Fruiting: July–September.

Etymology: The specific epithet of the new species derives from place of occurrence, i.e., Dihang-Dibang Biosphere Reserve.

Conservation Status: The new species are growing in a conserved site and far away from human habitation, so, there is no immediate threat for its survival. About 150 mature individuals were observed along a 1-km trek/transect during exploration. As the species is documented first time from well populated but from a single location it may place as Data Deficient (DD) category right now (IUCN, 2025).

Kuepferia otophoroides (Harry Sm.) Adr. Favre, Taxon 63: 351. 2014. *Gentiana otophoroides* Harry Sm. in Anz. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 63: 101. 1926.

Figs. 3 & S3

Perennial herbs up to 10 cm tall. Stems shortly branched, old sheaths persistent at base; flowering stems annual, ascending, slender, simple. Basal leaves in 1–3 rosettes, usually crowded; petiole 0.5–2 cm, membranous; leaf blade narrowly elliptic to oblong-spatulate, 1.5–3 × 0.5–1 cm, base narrowed, apex rounded, veins 3. Stem leaves 2–3 pairs, subsessile; leaf blade ovate-lanceolate to ovate-elliptic, 1–1.8 × 0.5–0.8 cm, base cuneate, apex acuminate to obtuse, veins 3. Flowers terminal, solitary; pedicel slender, 2–11 mm. Calyx tube 4–5 mm; lobes linear-lanceolate, 4–7 mm, subequal, apex obtuse, 1-vein. Corolla white or pale yellow, with pale blue streaks, tubular, 2.5–3 cm; lobes ovate-elliptic, 1.2–1.5 cm, margin entire, apex obtuse; plicae auricular, 2–3 mm, apex acute. Stamens inserted at middle of corolla tube; filaments 8–10 mm; anthers 2–2.5 mm. Style 3–4 mm; stigma lobes linear, curved. Capsules ellipsoid, c. 1.2 cm. Seeds light brown, fusiform.

Flowering & Fruiting: June–September.

Distribution: China: SE. Tibet to NW. Yunnan. India: Arunachal Pradesh, Upper Siang.

Specimen examined: Upper Siang, Pavo to Psonga (28º58'916" N & 95º14'347" E), Teetapuri (28º57'990" N & 95º14'980" E), 3300–4500m, 07.08.2012, *Pathak & G. Krishna 56520* (CAL, Barcode no. CAL0000330019).

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Supplementary materials are available from the journal website