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NOTE

Infraspecific Variation in *Gentiana macrauchena* (Gentianaceae), the Extension of its Known Range to India and Lectotypification of the Name *Gentiana incompta*

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ABSTRACT: Infraspecific morphological variation in *Gentiana macrauchena* C. Marquand (Gentianaceae) is discussed. The name *Gentiana incompta* Harry Sm. is lectotypified. *Gentiana macrauchena*, previously known as a Chinese endemic species, is recorded in India for the first time. The present discovery constitutes an extension of its known range towards the west in the Sikkim Himalaya, India. A detailed description, illustrations, and notes on the morphological variation of characters of the species are provided. An IUCN conservation status in India and the world is proposed based on field observations and literature including herbarium studies. Comments are also made on the spatial distribution of the species.

KEY WORDS: *Gentiana incompta*, *Gentiana macrauchena*, India, infraspecific variation, lectotype, new record, Sikkim Himalaya.

INTRODUCTION

The genus *Gentiana* L. consists of more than 361 species and is distributed in both the New and Old World (Ho and Pringle, 1995; Mabberley, 2009; Maity, 2014). The members of the genus are mostly concentrated in the temperate and alpine regions with a few exceptions in high-altitude tropical and subtropical forests. To date 63 species have been recorded in India, and most of them are from the Himalaya (Garg, 1987; Maity, 2014). During extensive fieldwork on subalpine and alpine landscapes in North Sikkim in recent years, a few specimens of an interesting *Gentiana* were collected. The annual habit, solitary, terminal flower, symmetrical and relatively wide plicae in proportion to the width of the lobes, morphology of the capsule, including the nature of gynophore, and morphology of the seed immediately placed these plants in *Gentiana* sect. *Chondrophyllae* Bunge. Critical analysis of the specimens and studies of the literature (Marquand, 1931; Smith, 1936; Ho and Pringle, 1995) confirmed their identity as *Gentiana macrauchena* C. Marquand.

Gentiana macrauchena C. Marquand is a well–defined species. Five years after its description by Marquand (1931), Smith (1936) described *Gentiana incompta* Harry Sm., based on specimens from western Hubei, China. However, *G. incompta* is now considered synonymous with *G. macrauchena*. All of the characters attributed to *G. incompta* fall within the range of variation of *G. macrauchena* (Ho and Pringle, 1995). The present study has confirmed that the holotype of the name *Gentiana incompta* Harry Sm. is missing, and that name, therefore, is lectotypified here.

Gentiana macrauchena has hitherto been thought to be endemic to China and restricted to only a few provinces of that country, viz., western Hubei, southern Shaanxi, eastern Sichuan, Yunnan, and southeastern Xizang (Ho and Pringle, 1995). The discovery of this species reported here extends its known distributional range to the northern part to the Sikkim Himalaya. A detailed description, illustrations, and relevant notes on infraspecific morphological variability, habitat, phenology, and distribution are provided for this species.

MATERIALS AND METHODS

Specimens were collected from the alpine meadows near Kalapathar Lake in north Sikkim, India, at an altitude about 4300 m. Properly preserved, dried, poisoned, and pressed herbarium specimens were deposited in CUH, including a few left unmounted for further detailed study. Flowers were dissected under a stereo binocular microscope for detailed characterization and illustration. For better circumscription of the species, high-resolution images of specimens at several herbaria, including the types of the names *G. macrauchena* and *G. incompta*, were also examined. Digital images of original material of *G. incompta* in different herbaria were also studied for lectotypification.

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TAXONOMIC TREATMENTS

Typification of the name *Gentiana incompta* Harry Sm.

Gentiana incompta Harry Sm. in Hand.-Mazz., Symb. Sin. Pt. 7: 952. 1936.

Lectotype: **CHINA**: W. Hubei, IV. 1904, *Wilson, Veitch Exp. 2764* (K, K000843586, digital image!), here designated. *Paratype*: **China**: NE-S.: Dschengkou (*Farges: Hb. Paris*) (P, P00513797, digital image!).

Harald (Harry) Smith (1936) described the species *Gentiana incompta* Harry Sm. based on two specimens, citing "W. Hubei, IV. 1904 (*Wilson, Veitch Exp.2764*: *Mus. Wien, Typus*)," deposited at the Vienna Museum (W), as the holotype, and "NE-S.: Dschengkou (*Farges: Hb. Paris*)" as a paratype, deposited at Museum National d'Histoire Naturelle, Paris (P).

Information from the Naturhistorisches Museum, Wien, states that no replicate of the collection *Wilson 2764*, nor any specimens now or formerly identified as of *Gentiana incompta* collected by others, is present at W (http://herbarium.univie.ac.at/database/search.php). Moreover, information on the type, as *Wilson, E.H. 2764*, from WU (Universität Wien, Faculty Centre of Biodiversity and others), states that the specimen was 'not found in WU' (http://herbarium.univie.ac.at/database/search.php). Thus it can be assumed that the holotype specimen is missing. A duplicate of *Wilson 2764* (isotype) exists at K. According to the International Code of Nomenclature for, algae, fungi and plants (McNeill *et al.*, 2012) any component of the collection *Wilson, Veitch Exped. 2764* constitutes the part of the 'original material.' Therefore, two components of Smith's original material are known to be extant i.e. *Wilson 2764* at K and *Farges s.n.* at P, the former being a part of the holotype collection. According to *Taxonomic Literature-2*, K is the principal repository of specimens collected by Ernest Wilson while he was employed by the Veitch nursery, so it is probably one of his best-quality specimens. The specimen *Wilson 2764* at K is selected and designated here as the lectotype of the name *Gentiana incompta* Harry Sm. in accordance with Art. 9.2, 9.11 & 9.12 of ICN (McNeill *et al.*, 2012).

Gentiana macrauchena C. Marquand, Bull. Misc. Inform. Kew.1931: 85. 1931; Ho & Pringle, in Wu & Raven, Fl. China 16:67.1995. [Figs.1,2,3]

Type: **CHINA**: S. E. Tibet, Tsarong: in fruit on open moist pasture and boulders on Ka-gwr-pw, Mekong-Salwin divide, lat. 28°25′N., 3600–3900 m., July 1917, *G. Forrest 14196* (holotype- E, E00001818, digital image!; isotypes-K, K000843585, digital image!; WSY, WSY0066931, digital image!).

Gentiana incompta Harry Sm. in Hand.-Mazz., Symb.Sin. Pt. 7: 952. 1936.

Annual, to 8 cm high with several branches from base; stems ascending, becoming more erect in fruiting, glabrous; basal leaves few to several, involucriform, broadly elliptic, ovate or ovate-orbicular, 0.4–2 × 0.3–1.5 cm, apex acute to mucronate or obtuse, margin thick cartilaginous, smooth, with distinct, thick mid vein and two strong and two week laterals (5–veined, particularly in broader lamina), subsessile; stem leaves 2–8 pairs, widely spaced at flowering and fruiting, distinctly shorter than internodes; lamina lanceolate or oblong, 4.5–6 × 1–2 mm, apex acuminate, acute or obtuse, margin ± broadly membranous, often papillate along lower half in lower leaves, midvein distinct; petioles membranous, connate to tubular sheath of 1.5–2 mm; flower solitary, terminal to each branch; pedicels 2–4 mm long, stout, to 1 cm long in fruiting; calyx narrowly campanulate, 7–11 mm; lobes triangular to broadly triangular, 1.5–3 × 0.7–1 mm, acute; corolla narrowly campanulate, 8–15 mm, blue; lobes ovate, 1.5–3 × 0.7–1 mm, obtuse to subacute, entire; plicae ovate–triangular, 1–1.5 × 1 mm, entire or erose; stamens equal, inserted near middle of corolla tube; filaments 1.5–3 mm, gradually widening toward base; anthers ellipsoid, 0.5–1.5 mm; capsules obovoid, 4.5–5.5 ×3.5 mm, winged along the sutures, gradually widening toward apex to c. 0.25 mm; gynophore stout, 1.5–5cm in dehisced capsules; seeds brown, triquetrous-ellipsoid (-trigonous), 0.8–1.5× 0.8 mm; testa reticulate.

Flowering: April-August.

Fruiting: June-September.

Distribution: INDIA [Sikkim]; CHINA: [Tibet, Xizang, Sichuan, Yunnan, Chongquing, Shaanxi, Xingshan, Hubei].

Habitat: Grows in grassy slopes, grass-covered or moss-covered rock lumps, mostly around high-altitude lakes in temperate to alpine forests [800–4430 m].

Specimens examined: **INDIA**: North Sikkim, above Kalapathar, near lake, 4300 m, 23 July, 2014, *Dey 21388 & 21389* [CUH].

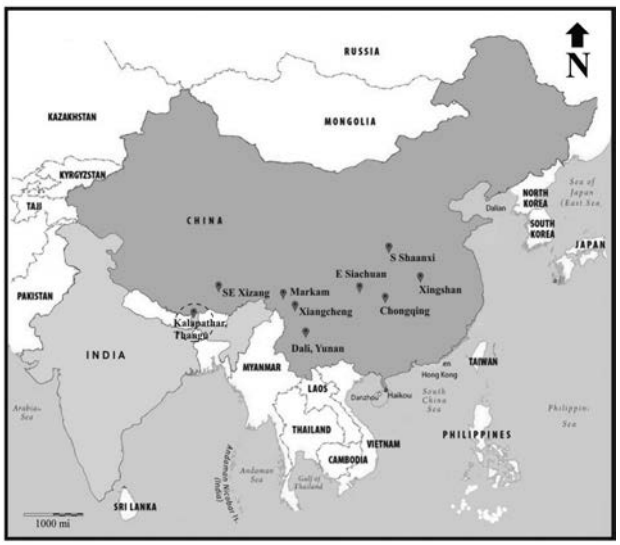


Fig.1. Geographic distribution of *Gentiana macrauchena* C. Marquand; circle shows new record of occurrence from India.

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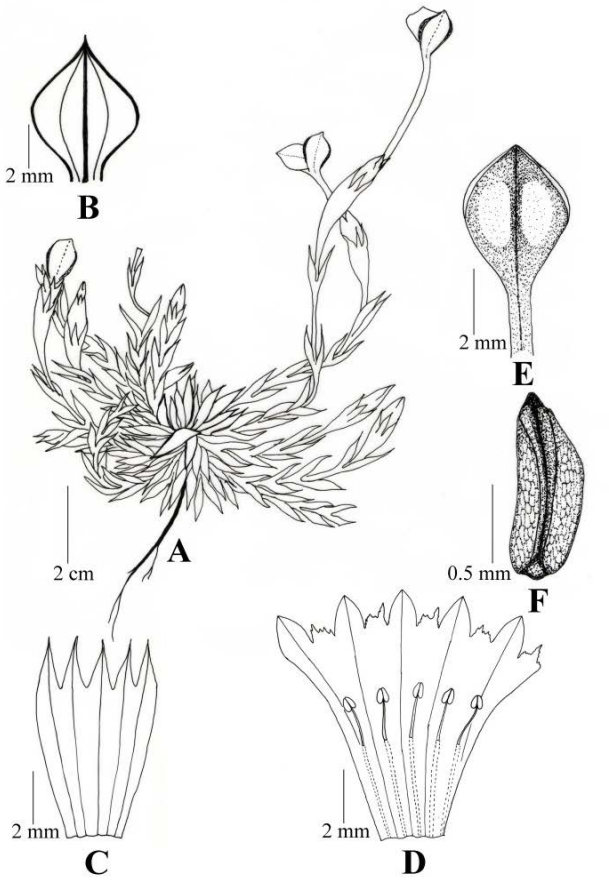


Fig.2. *Gentiana macrauchena* C. Marquand : A. Habit (basal leaves completely covered by the cauline leaves); B. Basal leaf; C. Split calyx (adaxial face); D. Split corolla (adaxial face) showing epipetalous stamens; E. Capsule; F. Seed. [drawing from *Dey21388*–CUH].

IUCN threat status: In India the species is at present known only from one population consisting of 5 or 6 individuals discovered in the alpine pasture of north Sikkim. Repeated searches around that site and also in the Thangu and Lhonak valleys in two successive years (2013-14), and frequent exploration in different places of Sikkim Himalaya since 1999, have failed to locate any other populations. This species has not yet been assessed for the IUCN Red List, but is in the Catalogue of Life (http://www.iucnredlist.org, version 2015.3; searched 16.11.2015). Under such a situation it is best to consider the species as Critically Endangered (CR D) in India (IUCN, 2014). Apart from the five type specimens, three of *Gentiana macrauchena* C. Marquand and two of *G. incompta* Harry Sm., only 10 specimens have been located, three in the Herbarium of the Arnold Arboretum, Harvard University Herbaria (HUH–A), viz., barcodes 00308318, 00308325& 00308870, collected in 2000, 2004 and 2006 respectively, and seven in the Chinese National Herbarium (PE), of which one had been collected in 2009 (PE, 02005693, digital image!) and the others in

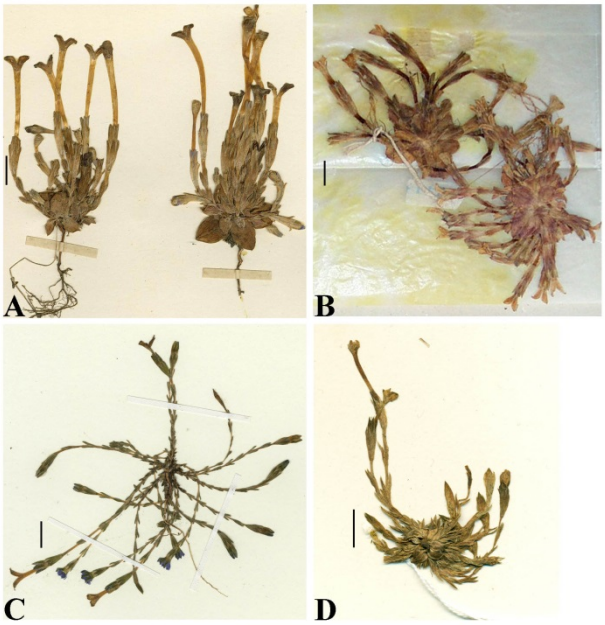


Fig.3. Infraspecific variation in *Gentiana macrauchena* C. Marquand– different morphoforms: A. *G. Forrest 14196* (holotype– E, E00001818); B. Specimen no. 57671 , acc. no. 633777 (PE, 00074005); C. *D. E. Boufford & al. 30647* (HUH, 000308325); D. *Dey 21388* (CUH). Scale bar 1.0 cm.

1957–58 (PE, 00073999, 00074000, 00074001, 00074003, 00074004 & 00074005, digital images!). The specimen no. 100126, acc. no. 645811, 00074002, (PE, digital image!) collected from Chongquing (1300 m amsl) was not included in the study because of uncertainty as to its correct identification. Therefore, it is assumed that the species is of very rare occurrence and may be Endangered (EN D) or Vulnerable (VU D) globally.

DISCUSSION AND NOTES ON INFRASPECIFIC VARIATION

Notably, the recently collected specimens from Sikkim, India are a little smaller in almost all of both the vegetative and floral parts (basal leaves few, 4–5.5 × 3–5 mm vs. several, 8-10 × 5-7 mm; calyx 7–8 mm vs. 8-11 mm; calyx lobes 1.5–2.5 mm vs. 2.5-3 mm; corolla 0.8–0.9 cm vs. 1.3-1.5 cm; corolla lobes c. 1.5 mm vs. 2-3 mm; filaments c.1.5 mm vs. 2-3 mm; anthers c. 0.5 mm vs.1.3-1.5 mm). These differences in the quantitative characters are considered here to be geographical or ecological responses to the alpine habitat of the Sikkim Himalaya. On the other hand, significantly, the qualitative characters are largely the same. In many cases the ratio of different floral parts or the ratio of parts of floral whorls/members is very important for delimitation of species as taxonomically, the ratio of calyx lobe/calyx tube is more characteristic for a species of *Gentiana* than the absolute size of the calyx lobe or calyx tube (A. Favre, pers. com.). Although variation within this species as

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Table 1.Comparison of characters to recognize two 'Forms' of *Gentiana macrauchena* C. Marquand.

Character state	Form 1	Form 2
Stem	Short, 1.5–3 cm, generally stout (except one PE specimen)	Long, 3–8 cm; generally slender
Basal leaves	Large, 8-10 × 5-7 mm, several, membranous	Small, 4–5.5 × 3–5 mm, few, coriaceous or even absent
Stem leaves	Mostly 2–4, wider, 1.5–2 mm across; paex reflexed away from the stem	Mostly 4–7, narrower, 1–1.5 mm across; apex tend to curve towards the stem
Flowers	Larger as 1.3-1.5 cm	Sikkim flowers smaller as 0.8–0.9 cm.

circumscribed here differs somewhat in the absolute sizes of plant parts, the Sikkim plants do not differ appreciably in the taxonomically more important relative proportions of the plant parts.

With this discovery, *Gentiana macrauchena* is now known to have a very wide distributional range from the Sikkim Himalaya far eastward to the Hubei province of China. The difference in plant height and the size of the leaves, other floral parts, etc., between the Sikkim plants as well as most of the Tibet plants, particularly those collected by Boufford *et al.* in 2000, 2004 and 2006 (all at HUH), and *G. macrauchena*, as the latter was described by Marquand (1931) and *G. incompta* as described by Smith (1936), may be attributable to growing conditions in the respective habitats (microhabitats).

Some other species in sect. *Chondrophyllae* do, it seems, have extensive and sometimes disjunct ranges. For example, *Gentiana fremontii* Torrey from southern California does not appear to be taxonomically separable from *G. fremontii* from Alberta, nor *G. prostrata* Haenke in California from that species in Colorado, nor *G. sedifolia* Kunth in Costa Rica and Panamá from that species in Ecuador.

Although Ho and Pringle (1995) said that the basal leaves were withered by the time of anthesis, all of the specimens examined in the various herbaria, including the newly collected material from Sikkim Himalaya, show the normally persistent structure of the lamina at flowering and fruiting. However, the basal involucrate leaves are few or poorly developed or absent in the Sikkim as well as the Tibetan plants.

Ho and Pringle (1995) described the plicae of *Gentiana macrauchena* as entire, but in the image of the paratype of *G. incompta*, *Farges s.n.* it is clearly erose in many of the flowers. Moreover, in the protologue of *G. incompta*, Smith (1936) explicitly stated that the 'folds (plicae) of lobes are approx. $^{2}/_{3}$ as long as the lobes, approx. 2 mm wide, triangular, subacute to acute, entire to somewhat dentate.' The nature of the plicae is always important in determining the identity of *Gentiana* species. In the present treatment the plicae are considered to be entire to erose. The seed surface was described as rugose by Marquand (1931), but it is clearly reticulate in the recently collected specimens, as also mentioned by Smith (1936) and Ho and Pringle (1995).

As indicated above, the present collection and the examination of the digital images of the specimens deposited at different herbaria, including the type specimens, reveal significant morphological variation within the species. From the detailed study of this species two distinct forms were recognized. 'Form 1' is represented by the type specimens of both *Gentiana macrauchena* and *G. incompta* and includes specimens collected from Xingshan, Chongquing (Hubei), Dali (Yunnan) and Sarong (SE Tibet). These plants are characterized by a comparatively tufted habit, the stem short and stout, basal involucrate leaves several and significantly larger, ± membranous, stem leaves few (usually up to 2 pairs), wider and abruptly tapering to a subacute to nearly obtuse apex. Also, the stem leaves are characteristically reflexed from above the middle outward from the stem. Notably, almost all of these specimens were collected from comparatively low altitudes as well as in different geo-climatic conditions.

The 'Form 2' plants are represented by the specimens collected from Yajing, Xiangcheng (Sichuan), Xizang (Tibet) and Sikkim (India), at very high altitudes in alpine pasture habitats. The plants are diffuse or tufted, with the stems very long, to 8 cm, slender, basal involucrate leaves few, coriaceous, or even very poorly developed or absent, apex sharply acute to acuminate, stem leaves several, to seven pairs or even more, gradually tapering to a finely acute to acuminate apex [Sikkim plants and several Sichuan plants (*Boufford et al.* 36034, PE, barcode 00308870, digital image!) with distinctly acuminate apices], and in contrast to 'Form 1' the leaves tend to curve from the middle towards the stem. A comparison of the two forms is appended in Table 1.

Among the Chinese specimens of 'Form 1', one collected from Chongquing, China (PE, barcode 00074005, digital image!) is comparatively slender and quite similar to 'Form 2' (Fig.3B). The basal rosette leaves, in general, are several as well as much larger in the Chinese specimens, as is also mentioned in the literature (Marquand, 1931; Smith, 1936; Ho and Pringle 1995).

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The capsules of sect. *Chondrophyllae*, in general, mature within the corolla, and just after maturation the gynophores grow very rapidly and protrude much beyond the corolla, sometimes reaching 5 cm or even more in *Gentiana macrauchena*. An interesting observation is also noted regarding the spatial distribution of the individuals of the species *Gentiana macrauchena*. In earlier literature (Marquand, 1931; Smith, 1936; Ho and Pringle, 1995) the plants were described as occurring in subtropical to temperate habitats at 800–2800 m. However, the recent collections were made from alpine pastures [Sikkim c. 4300 m and Xizang (Tibet) and Sichuan provinces at 3600–4430 m]. *Gentiana macrauchena* 'climbs' to higher altitudes toward the western biogeographic regions. The specimens of *G. macrauchena* from eastern Hubei provinces were collected at low altitudes, and the species gradually ascends to higher altitudes towards the western regions, crossing 1300 m in Chongquing and ultimately reaches open alpine pastures at Sichuan, Tibet and Sikkim at more than 4400 m.

Floristically the eastern parts of Nepal and Sikkim, along with Darjeeling in West Bengal, Arunachal Pradesh of India, Bhutan, and SE Tibet, share a high percentage of species similarity and thus constitute a distinct phytogeographical region, '*The Eastern Himalaya.*' The crucial position of the Chumbi valley acts almost as a 'corridor' for species migration. As a result different Chinese elements have often been migrated toward Sikkim or Bhutan. The frequency of new records of Chinese elements from Sikkim in recent years supports this observation (Maity and Maiti, 2007, 2009; Maity, 2010).

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