

Metagentiana, a new genus of Gentianaceae¹

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Abstract. The evidence from gross morphology, floral anatomy, chromosomes, palynology, and embryology all indicates that sect. *Stenogyne* is discordant within the genus *Gentiana* and is as distinct from the other sections of *Gentiana* as are other genera, such as *Tripterosperrum* and *Crawfurdia*. In light of these characters, sect. *Stenogyne* is removed from *Gentiana* and given generic rank as the new genus *Metagentiana*. It is more related to *Tripterosperrum* and *Crawfurdia* than to *Gentiana*, though it is more primitive than the first two genera. Together with *Tripterosperrum* and *Crawfurdia* the new genus forms a monophyletic group, which is the sister group to the genus *Gentiana*. Fourteen new combinations required at specific rank are proposed.

Keywords: *Gentiana*; *Gentianaceae*; *Metagentiana*; New Genus; Taxonomy.

Introduction

Gentiana sect. *Stenogyne* was established by Franchet (1884) and was revised by Kusnezov (1894). It contains fourteen species: Ten of these are highly restricted to southwestern China; two are relatively widespread in northwestern and central China; one extends to eastern Burma from southwestern China, and one is endemic to Thailand. *Stenogyne* is the most disputable and poorly known of *Gentiana*'s 16 sections. Smith (1965) considered it a somewhat mysterious group in *Gentiana* from its morphological characters, which suggested a closer affinity with *Tripterosperrum* or *Crawfurdia* than with other sections of *Gentiana*. Löve and Löve (1976) recommended the transfer of this section to the genus *Tripterosperrum*, tentatively as a subgenus (*Tripterosperrum* subgen. *Stenogyne*). However, they had no karyological information to make a further delimitation. Yuan and Küpfer (1993) reported chromosome numbers for six species of this section for the first time and suggested a specialized and isolated position of this section in the genus *Gentiana* because of its higher and obviously secondary basic chromosome numbers $x=17, 21,$ and 23 . Three years later (Yuan et al., 1996), based on the nucleotide sequence of the internal transcribed spacer (ITS) of nuclear Ribosomal DNA, they further suggested excluding sect. *Stenogyne* from *Gentiana* and classifying it as a distinct genus. However, the necessary taxonomic changes were never made. Halda (1995) made sect. *Stenogyne* a subgenus, still positioned in the genus *Gentiana*. Since 1990, we have examined gross

morphology, floral anatomy, karyology, pollen morphology and embryology for most genera in the subtribe *Gentianinae* and have published a series of papers (Chen et al., 1997, 1998, 1999a, 1999b, 2000; Ho and Liu, 1990, 1999; Ho and Pringle, 1995; Ho et al., 1994, 1996, 1997, 1999, 2000; Liu and Ho, 1996a, 1996b, 1997; Xue et al., 1999a, 1999b). The present paper attempts to bring together these interactive studies of various materials relating to *Gentiana* sect. *Stenogyne* with the hope of better understanding its classification and systematic position.

Character Analyses

Based on detailed comparisons of characters such as gross morphology, floral anatomy, chromosomes, pollen morphology, and embryology, this study presents a complete documentation of *Gentiana* sect. *Stenogyne*. The concise descriptions of these characters used for the present study are as follows.

Gross Morphology

Most species in *Gentiana* sect. *Stenogyne* are annual herbs, but a few are perennials with extremely short rhizomes. The stem is erect and branched. Leaves are sessile, broadly ovate to ovate-triangular. Flowers are many, with each solitary and sessile at the end of stems and branches, subtended by a pair of leaf-like bracts. The calyx is tubular; midveins of the lobes are keeled and winged into the calyx-tube. The corolla is funnellform, and its plicae is long and wide. The margin of the plicae may be erose, denticulate, or fimbriate. The stamens are unequal and more or less curved downwards unilaterally. There are 5 nectaries at the base of the ovary. The style is filiform and about as long as the ovary. The capsules are cylindrical. The seeds are triquetrous with the three edges winged or rarely unwinged. Sect. *Stenogyne* is very

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special within *Gentiana*. It is similar to the remaining sections* of *Gentiana* in the characters of habit, stem, inflorescence, plicae etc. It is different from the remainder of *Gentiana* in the characters of calyx, stamen, style, and seed, but is similar to the genus *Tripterosperrum* in these characters. Moreover, sect. *Stenogyne* is easily distinguished from all groups by its having sessile broad ovate to ovate-triangular leaves and large leaf-like bracts. Compared with the remainder of *Gentiana*, *Tripterosperrum*, and *Crawfurdia* on gross morphology (Table 1), sect. *Stenogyne* is more similar to *Tripterosperrum* than to the rest of *Gentiana*, because sect. *Stenogyne* is similar to the rest of *Gentiana* on the vegetative organs and similar to *Tripterosperrum* on the reproductive organs.

Floral Anatomy

We have reported the floral anatomy of *Gentiana* sect. *Stenogyne*, *Tripterosperrum* and *Crawfurdia* for the first

time (Chen et al., 1999b, 2000; Ho et al., 2000). The floral anatomic characters of sect. *Stenogyne* conform to the following basic framework of the subtribe *Gentianninae*. These main characters are: (1) the receptacle shows an amphiphloic siphonostele; (2) the calyx and corolla each have 5 traces dividing into three each; (3) squamellae, in the form of minute multicellular filaments, occur at the base of calyx tube; (4) the 5 stamen traces become 5 stamen vascular bundles; (5) the two carpels have 3 vascular bundles each (1 dorsal and 2 ventral). Besides these basic characters, sect. *Stenogyne* has some characters that differ from the rest of the subtribe, such as 12 sepal vascular bundles and vascular tissue entering the base of the secretory tissue of the nectaries. Compared with the remaining sections of *Gentiana*, *Tripterosperrum* and *Crawfurdia* on floral anatomy (Table 2), sect. *Stenogyne* is considered an intermediate between the rest of *Gentiana* and *Crawfurdia*. The sepal vascular bundles

Table 1. The morphological comparison of *Gentiana* sect. *Stenogyne* with allied genera.

Characters	<i>Gentiana</i> sect. <i>Stenogyne</i>	The remaining sections of <i>Gentiana</i> *	<i>Tripterosperrum</i>	<i>Crawfurdia</i>
Habit	Annuals, rarely perennials	Annuals or perennials	Perennials	Perennials
Stems	Erect with many branches	Erect to ascending with many flower stems or branches	Twining or trailing with few weak branches	Twining or trailing with few weak branches
Rhizomes	Absent, rarely disk-rhizome	Absent or shortened	Long, stout and branched	Long, stout and branched
Flowers	Solitary and terminal at branches	Solitary and terminal at branches or in terminal cymes	In terminal and axillary cymes	In terminal and axillary cymes
Bracts	As large as to larger than leaves	Absent, rarely present	Smaller than leaves	Smaller than leaves
Calyx	Tube always entire, with linear-lanceolate to linear lobes, midvein outside strongly keeled and decurrent into wings of calyx tube	Tube entire to split, with various lobes	Tube always entire, with linear-lanceolate to linear lobes, midvein outside strongly keeled and decurrent into wings of calyx tube	Tube split down one side, with triangular lobes
Corolla plicae	Developed with long, broad and erose to fimbriate margin	Developed with long, broad and various margin	Not developed with short, narrow and entire margin	Not developed with short, narrow and entire margin
Stamens	Unequal, apically decurved	Equal, straight	Unequal, apically recurved	Equal, straight
Style	Filiform, as long as ovary	Linear to cylindrical, shorter than ovary	Filiform, as long as to longer than ovary	Filiform, as long as to longer than ovary
Nectaries	Small, on gynophore	Small, on gynophore	Large, forming a collar-like disk around gynophore	Small, on gynophore
Seeds	Seeds triquetrous, three edges form three equal faces	Neither triquetrous nor compressed	Triquetrous to compressed with a narrow to discoid wing, three edges form three equal to extremely unequal faces	Compressed with a discoid wing, three edges form three extremely unequal faces
Gynophore	Short so that capsule included in persistent corolla	Long (rarely short) so that capsule exerted from (rarely included in) persistent corolla	Long so that fruit exerted from persistent corolla	Long so that capsule exerted from persistent corolla
Fruit	Capsule	Capsule	Capsule or berry	Capsule

*Notes: the remaining sections of *Gentiana* comprise the sections *Otophora*, *Cruciata*, *Monopodiae*, *Kudoa*, *Frigidae*, *Phyllocalyx*, *Isomeria*, *Microsperma*, *Gentiana*, *Calathianae*, *Ciminalis*, *Pneumonanthae*, *Dolichocarpa*, *Chondrophyllae* and *Fimbricorona*.

number 15 in the remaining sections of *Gentiana*, 10 in *Crawfordia*, and 5 in *Tripterospermum*. The vascular tissue is conspicuously developed in *Tripterospermum*, weak in *Crawfordia*, and absent in the remaining sections of *Gentiana*. The cohesion and reduction of vascular bundles were considered advanced characters by many researchers (Lindsey, 1940; Puri, 1951; Eames, 1961; Davis, 1966; Liang and Zhang, 1986). The vascular tissue in the nectary also was considered advanced by Deng (1995). According to evolutionary trends of floral anatomy, we consider that sect. *Stenogyne* is more primitive than both *Crawfordia* and *Tripterospermum*, but is more advanced than *Gentiana*.

Karyology

Chromosome numbers have been reported for eight species in sect. *Stenogyne*. These species have $2n=34, 42$ and 46 chromosomes. Their basic number should therefore be $X=17, 21$ and 23 . All of these species are considered diploids (Table 3a). Besides the chromosome numbers, karyotype analyses have been done for five species. Their karyotypes are more asymmetrical, with a higher proportion of submetacentric and acrocentric chromosomes. The classification of the karyotype belongs to 3A and 2B, rarely 2A types. The karyotypic asymmetry index (As. K%) has a mean value of 62.02 (Table 3b). Apparently, sect. *Stenogyne* is extremely special within *Gentiana* with

Table 2. A floral anatomic comparison of *Gentiana* sect. *Stenogyne* with allied genera.

Characters	<i>Gentiana</i> sect. <i>Stenogyne</i>	The remaining sections of <i>Gentiana</i>	<i>Tripterospermum</i>	<i>Crawfordia</i>
Numbers of vascular bundles				
In calyx tube	12	15	5	10
In corolla tube	15	15	15	15
In stamens	5	5	5	5
At base of ovary	6	6	6	6
Structure of nectaries				
Epidermis	Present	Present	Present	Present
Secretory tissue	Present	Present	Present	Present
Vascular tissue	Weak	Absent	Development	Weak

Table 3a. Known chromosome numbers in *Gentiana* sect. *Stenogyne*.

Species	Chromosome numbers		References
	$2n$	n	
<i>G. expansa</i>	34		Yuan and Küpfer, 1993
<i>G. gentilis</i>		21	Yuan and Küpfer, 1993
<i>G. primuliflora</i>	42		Yuan and Küpfer, 1993
<i>G. pterocalyx</i>		17	Yuan and Küpfer, 1993
<i>G. rhodantha</i>	46		Yuan and Küpfer, 1993
<i>G. serra</i>	34		Ho et al. (in press)
<i>G. striata</i>	46		Yuan and Küpfer, 1993; Ho et al. (in press)
<i>G. souliei</i>	46		Ho et al. (in press)

Table 3b. The chromosomal and karyotypical comparison of *Gentiana* sect. *Stenogyne* with allied genera.

Genera	Chromosome number		Karyotype asymmetry		References
	Recorded number ($2n$)	Suggested basic numbers (X)	Type	As.k%	
<i>Gentiana</i> sect. <i>Stenogyne</i>	46 (34, 42)	23 (17, 21)	3A, 2B (2A)	58.18-68.7; 62.02 in mean	Yuan and Küpfer, 1993; Ho et al. (in press)
The remaining sections of <i>Gentiana</i>	18, 20, 24, 26, 36, 40 (12, 14, 16, 22, 28, 30, 32, 38, 42, 44, 48, 52, 60, 72, 76, 96-98)	9, 10, 12, 13, 14, 15 (6, 7, 8, 11, 16, 21)	1A, 2A (3A, 1B, 2B, 3B)	52.69-60.27; 57.024 in mean	Yuan and Küpfer, 1993; Yuan, 1993
<i>Tripterospermum</i>	46 (20)	23 (10)	2B	58.67-66.3, 59.75 in mean	Chen, 1997; Shigenbu, 1984
<i>Crawfordia</i>	46	23	2B	61.46	Chen, 1997

Notes: the numbers in parentheses = rare numbers; infraspecific aneuploid numbers are not taken into account; As.k% = the karyotypic asymmetry index as defined by Arano (1963).

respect to karyological characters (high secondary basic chromosome numbers and asymmetric karyotypes). In contrast, sect. *Stenogyne* is nearly identical to both *Tripterospermum* and *Crawfordia* in these characters.

Embryology

Embryological data are a critical prerequisite to a complete understanding of the systematics of any taxon (Michael, 1991). We have studied embryology in twelve species of the subtribe *Gentianinae*. Among them *Gentiana striata* Maxim., *Gentiana lawrencei* var. *farreri* (I. B. Balfour) T. N. Ho, *Crawfordia delavayi* Franch., and *Tripterospermum cordatum* (Marq.) H. Smith and *T. chinense* (Migo) H. Smith represent sect. *Stenogyne*, other sections of *Gentiana*, *Crawfordia*, and *Tripterospermum*, respectively. The results indicated that the embryological characters of all four taxa conform to the basic framework of the subtribe *Gentianinae*: tetrasporangiate anthers; a dicotyledonous type of microsporangial development; simultaneous cytokinesis in the microsporocytes; tetrahedral microspore tetrads; 3-celled pollen; a superior, bicarpellary, and unilocular ovary; a unitegmic tenuinucellar ovule; a *Polygonum* type of megagametophyte; porogamous fertilization; nuclear endosperm; and a Physalis II variation of a Solanad type of embryogeny. Examining Table 4, it may be seen that the sect. *Stenogyne* is discordant with the remainder of *Gentiana* and differs from it in having a unitary original tapetum, uninucleate tapetal cells which do not protrude into the anther locule, middle layers of a 1-celled layer, a typical parietal placenta, a hypertropous ovule type, and ovules often arranged in four columns. The other sections of *Gentiana* have dual original tapetum, binucleate tapetal cells which elongate and protrude into the anther locule

to form "Trabeculae" and "Placentoids", 2-celled middle layers, a superficial parietal placenta, an anatropous ovule type, and ovules arranged in 10-30 columns. Sect. *Stenogyne* is more similar to both *Tripterospermum* and *Crawfordia* than to the remainder of *Gentiana* in embryological characters. With sect. *Stenogyne* both *Tripterospermum* and *Crawfordia* share the same unitary original tapetal and typical parietal placenta. In addition, *Tripterospermum* has the hypertropous ovule type while *Crawfordia* has no "Trabeculae" or "Placentoids." Many researchers have discussed the evolutionary trends of embryological characters (Lindsey, 1940; Eames, 1961; Gopal, 1962; Johri, 1984; Tobe, 1989; Johri et al., 1992). Primitive embryological characters usually comprise: a thick anther wall, several middle layers, single origin of tapetum, typical parietal placentation, eight rows of ovules, and an anatropous ovule. Advanced embryological characters include: a thin anther wall, an ephemeral middle layer, an amoeboid (invasive or intrusive) tapetum, and superficial placentation. Based on these trends and a comparison of embryological characters, sect. *Stenogyne*, *Tripterospermum*, and *Crawfordia* are more primitive than the remainder of *Gentiana*.

Palynology

We have examined the pollen morphology of 64 species representing *Gentiana*, *Tripterospermum*, and *Crawfordia* with both light microscopy and scanning electron microscopy. As shown in Table 5, sect. *Stenogyne* is similar to the rest of *Gentiana*, *Tripterospermum*, and *Crawfordia* in basic pollen features such as spheroidal to subspheroidal pollen grains of medium size, with the wall striate-imperforate to perforate. However, most species in sect. *Stenogyne* are similar to the rest of *Gentiana* by hav-

Table 4. The embryological comparison of *Gentiana* sect. *Stenogyne* with its allied genera.

Characters	<i>Gentiana</i> sect. <i>Stenogyne</i>	The remaining sections of <i>Gentiana</i>	<i>Crawfordia</i>	<i>Tripterospermum</i>
Epidermis				
Persistent	Yes	Yes	Yes	Yes
Fibrous thickenings	Yes	No	Yes	No
Endothecium				
Fibrous thickenings	Yes	Yes	No	Yes
Middle layers	1	2	1	1 or 2
Tapetum				
Origin	Unitary	Dual	Unitary	Unitary
Type	Glandular	Glandular	Glandular	Glandular
Trabeculae and Placentoids	No	Formed	No	Weak
Number of nuclei in cell	1	2 (more)	1	1
Microsporogenesis				
Mature pollen at shedding	3-celled	2- or 3-celled	3-Celled	3-Celled
Megasporangium (ovule)				
Type	Hypertropous	Anatropous	Anatropous	Hypertropous
Column numbers	4 (8 or 12)	10-30 (4 or 8)	8 (4 or 12)	4 (8 or 12)
Placentae				
Intrusion	No	No	No	No
Type	Typical parietal	Superficial parietal	Typical parietal	Typical parietal

Table 5. A comparison of pollen characters of *Gentiana* sect. *Stenogyne* with allied genera.

Taxa	Shape	Size polar axis × equatorial axis (μm)	Sexine character		
			Ornamentation	Lira width (μm)	Bacula in columellate layer
The remaining sections of <i>Gentiana</i>	Spheroidal, subspheroidal, prolate (perprolate, rhomboid)	22-48 (-60) × 20-35 (-50)	Striate-imperforate, -perforate, -foveolate, -reticulate to reticulate	(0.13-)0.4-0.7(-1)	1 (2) row
<i>Gentiana</i> sect. <i>Stenogyne</i>	Spheroidal, subspheroidal	37.3-45.3 × 30.6-35.3	Striate-imperforate to -perforate,	0.35 - >1	1 or 2 (3) rows
<i>Tripterospermum</i>	Spheroidal, subspheroidal	26-52 × 23-40	Striate-imperforate to -reticulate	>1 (<0.6)	2 (1) rows
<i>Crawfurdia</i>	Spheroidal, subspheroidal, (prolate)	25-48 × 23-40	Striate-imperforate to -perforate	>1 (<0.6)	2(1) rows

*Notes: the remaining sections of *Gentiana* comprise the sections *Otophora*, *Cruciata*, *Monopodiae*, *Kudoa*, *Frigidae*, *Phyllocalyx*, *Isomeria*, *Microsperma*, *Gentiana*, *Calathianae*, *Ciminalis*, *Pneumonanthe*, *Dolichocarpa*, *Chondrophyllae* and *Fimbricorona*.

ing lirae narrow (0.4-0.7 μm) and bacula erect, sometimes lobed at tops and arranged in one row at the columellate layer, and a few species are similar to *Tripterospermum* and *Crawfurdia* by having lirae wide (>1 μm) and bacula erect, not lobed at tops and arranged in two or more rows. Therefore, the pollen morphological characters of sect. *Stenogyne* are intermediate between the remainder of *Gentiana* and both *Tripterospermum* and *Crawfurdia*.

Systematic Position

Comprehensive comparative studies and synthetic analyses of the characters relating to gross morphology, floral anatomy, chromosomes, palynology and embryology indicate that (1) sect. *Stenogyne* is quite different from the other sections of *Gentiana* in the following respects: (A) karyology: a high secondary basic chromosome number and asymmetric karyotype; (B) embryology: a unitary original tapetum, uninucleate tapetal cells, no “trabeculae” or “placentoids”, middle layers of 1-celled layer, a typical parietal placenta, a hypertropous ovule type, ovules often arranged in four columns; (C) gross morphology: a keeled and winged calyx-tube, unequal and unilaterally curved downwards stamens, a filiform and long style, and triquetrous seeds; (2) although sect. *Stenogyne* is similar to *Tripterospermum* and *Crawfurdia* in these karyological, embryological, and morphological characters, it differs from both in annuals, erect stems, many flowers solitary and terminal at ends of branches, and long and wide plicae, and also from *Crawfurdia* in characters of stamens, ovule type and fibrous thickenings of endothecium and from *Tripterospermum* in having no “trabeculae” or “placentoids”; (3) sect. *Stenogyne* is different from all taxa in sessile broadly ovate to ovate-triangular leaves, large leaf-like bracts, 12 sepal vascular bundles, and weak vascular tissue in nectaries.

The evidence from various characters indicates that sect. *Stenogyne* is discordant within the genus *Gentiana* and is as distinct from the other sections of *Gentiana* as other genera, such as *Tripterospermum* and *Crawfurdia*.

We here remove sect. *Stenogyne* from *Gentiana* and treat it as the new genus *Metagentiana*. As regards its systematic position, *Metagentiana* is more related to both genera *Tripterospermum* and *Crawfurdia* than to the genus *Gentiana*, though it is more primitive than the former. Together with *Tripterospermum* and *Crawfurdia*, the new genus forms a monophyletic sister group to *Gentiana*.

Taxonomic Treatment

Metagentiana T. N. Ho & S. W. Liu, gen. nov.—TYPE: *Metagentiana primulifolia* (Franchet) T. N. Ho & S. W. Liu.

Gentiana sect. *Stenogyne* Franchet, Bull. Soc. Bot. France 31: 375 (1884). *Gentiana* subgen. *Stenogyne* (Franchet) Halda, Acta Mus. Richnov. 3: 29. 1995.—TYPE: *G. primulifolia* Franchet.

Hoc novum genus Gentianacearum Gentianae et Tripterospermo affine, a primo staminibus inaequalibus, ab apicibus unilateraliter decurvis, stylis filiformibus, ovario fere aequilongis vel longioribus, seminibus triquetris, cum anguste alis, a secundo floribus solitariis sessilibus, plicis corollae longis latisque, margine denticulatis usque fimbriatis, nectare parve, non discifore, ab utroque bracteis florum amplis foliaceis, vasculis calycis 12 bene recedit.

This new genus is related to *Gentiana* and *Tripterospermum*. It differs from the former by having stamens unequal and apically decurved, filiform style as long as the ovary, and seeds triquetrous with narrow wings on each edge. It differs from the latter by having flowers solitary and terminal at branches, corolla plicae long and wide with the margin erose to fimbriate, nectaries small, not disk-like. It differs from both by having large bracts at the bases of flowers and 12 vascular bundles in the calyx.

Annuals, rarely perennials. Stems erect, much branched from base or rarely simple. Flowers sessile, solitary, terminal on branches. Calyx keeled or winged. Plicae asymmetrical, very oblique. Style filiform, about as long

as ovary. Capsules included in marcescent corolla, cylindrical, wingless. Seeds triquetrous with three equal faces, the edges winged or rarely wingless; seed coat reticulate, rarely alveolate.

Distribution. China (Yunnan, Sichuan, Guichou, S Shanxi), Myanmar, Thailand. 14 species.

Key to *Metagentiana* and its Allied Genera

- 1a. Flowers ebracteate (except a few species in sect. *Pneumonanthe*); style linear to cylindrical, shorter than ovary; seeds ellipsoid, ovoid to globose, not triquetrous; calyx tube with 15 vascular bundles
..... *Gentiana* L.
- 1b. Flowers bracteate; style filiform, as long as to longer than ovary; seeds triquetrous with three winged edges (rarely wingless); calyx tube with 5-12 vascular bundles.
- 2a. Stems erect, neither twining nor trailing; flowers sessile, solitary and terminal on branches; bracts as large as to larger than stem leaves; fruits included in persistent corolla; annuals, rarely perennials with stout and extremely shortened disclike-rhizome
..... *Metagentiana* T. N. Ho & S. W. Liu
- 2b. Stems terete, twining or trailing; flowers pedicellate, 1-5 in terminal and axillary cymes; bracts much smaller than stem leaves; fruits exerted from persistent corolla; perennials with stout, long and branched rhizomes.
- 3a. Nectaries conspicuously developed, forming a collarlike disc around gynophore; stamens asymmetrical, unequal in length, apically decurved; fruit a capsule or berry; calyx tube with 5 vascular bundles
..... *Tripterospermum* Blume
- 3b. Glands small, on gynophore; stamens equal in length, straight; fruits a capsule; calyx tube with 10 vascular bundles
..... *Crawfordia* Wallich

New Combinations

1. *Metagentiana alata* (T. N. Ho) T. N. Ho & S. W. Liu, comb. nov.

Gentiana kusnezowii Franchet, Bull. Soc. Bot. France 43: 492. Nov. 1896, non Gilg (May 1896). *Gentiana alata* T. N. Ho in T. N. Ho & S. W. Liu, Bull. Nat. Hist. Mus. London (Bot.) 23(2): 57. 1993.—TYPE: China, Yunnan, Kunming (Yunnan-fou), in 1895, *Delavay s. n.* (holotype: P!)

Distribution. China (C Yunnan). Clearings in forests; 1,200-2,000 m.

2. *Metagentiana australis* (Craib) T. N. Ho & S. W. Liu, comb. nov.

Gentiana australis Craib, Bull. Misc. Inform. Kew 1916: 266. 1916. *Gentiana leptoclada* I. B. Balfour & Forrest

subsp. *australis* (Craib) Halda, Acta Mus. Richnov. 3: 30. 1995.—TYPE: Thailand, Siam, Doi Chieng Dao, on rocky ground, 1,650-1,770 m, 28 Jan 1913, A. F. G. Kerr 2865 (holotype: K!; isotypes: BM!, E!, P!).

Distribution. Thailand. Limestone rocks, scrub; 1,650-1,800 m.

3. *Metagentiana eurycolpa* (Marquand) T. N. Ho & S. W. Liu, comb. nov.

Gentiana eurycolpa Marquand, Bull. Misc. Inform. Kew 1931: 71. 1931. *Gentiana gentilis* Franchet subsp. *eurycolpa* (Marquand) Halda, Acta Mus. Richnov. 3: 30. 1995.—TYPE: China, Yunnan, [Kunming], Lagu (Lakou), on grassy hills, 2,400-3,000 m, *Maire 7404* (holotype: UC!; isotypes: K!, US!). Paratypes: China, [Kunming], Kin-tchong-shan, 2,600 m, *Maire 2910* (K!, UC!); without locality, *Henry 10023* (K!, MO!, PE!).

Distribution. China (NE Yunnan, SW Sichuan, Guizhou). Grassland slopes; 2,400-3,000 m.

4. *Metagentiana expansa* (H. Smith) T. N. Ho & S. W. Liu, comb. nov.

Gentiana expansa H. Smith in Handel-Mazzetti, Symbolae Sinicae 7: 951. 1936.—TYPE: China, Yunnan, Yanjin Xian (Beyndjing), 28 Sep 1915, *Semon Ten 282* (holotype: B, not seen, probably not extant; isotype: UPS!). Paratypes: China, Yunnan, Yanjin Xian (Beyndjing), 24 Sep 1919, *Semon Ten 311 & 1393* (not seen); Binchuan (Bintschwan)—Dali, Dec 1906, *Ducloux 4875* (P!).

Distribution. China (NW & C Yunnan). Grassland and gravel slopes, forest margins; 1,100-2,100 m.

5. *Metagentiana gentilis* (Franchet) T. N. Ho & S. W. Liu, comb. nov.

Gentiana gentilis Franchet, Bull. Soc. Bot. France 43: 491. 1896.—TYPE: China, Yunnan, Kunming (Yunnan Sen), Sep 1895, *Delavay s. n.* (holotype: P!).

Distribution. China (C & E Yunnan). Woodland margins, forests; 2,000-2,700 m.

6. *Metagentiana leptoclada* (I. B. Balfour & Forrest) T. N. Ho & S. W. Liu, comb. nov.

Gentiana leptoclada I. B. Balfour & Forrest, Notes Roy. Bot. Gard. Edinburgh 4: 71. 1907.—TYPE: China, NW Yunnan, Jinshajiang (Yangtse) Valley, [Deqen], Shiti-ko, 7,000-9,000 ft., Oct 1904, *Forrest 7409* (holotype: E!; isotype: K!; typographic error "409").

Gentiana hapalocaula Marquand, Bull. Misc. Inform. Kew 1928: 52. 1928.—TYPE: China, NW Yunnan, [Lijiang], Tongshan in the Yangtze bend, 27°20' N, amongst grass in open situation, 3,000 m, Oct 1913, *Forrest 11444* (holotype: E!; isotypes: BM!, K!).

Distribution. China (NW Yunnan, SW Sichuan). Valleys, forests; 2,100-3,000 m.

Notes. The stamens of *G. leptoclada* are unequal and variable (either some stamens longer than the corolla pliae or all shorter than the pliae). *Gentiana hapalocaula*

was recognized as a distinct species in earlier treatments and distinguished from *G. leptoclada* by stamens shorter than the corolla pliae. Clearly, *G. hapalocaula* can not be maintained.

7. *Metagentiana melvillei* (S. Moore) T. N. Ho & S. W. Liu, comb. nov.

Gentiana melvillei S. Moore, J. Bot. (London) 43: 143. 1905. *Gentiana primuliflora* Franchet subsp. *melvillei* (S. Moore) Halda, Acta Mus. Richnov. 3: 30. 1995.—TYPE: Myanmar, Shan States, wayside at Pyinsamben, 3,000 ft., Oct 1903–Jun 1904, *Melville s. n.* (holotype: BM!).

Distribution. E Myanmar. Ca. 900 m.

8. *Metagentiana primuliflora* (Franchet) T. N. Ho & S. W. Liu, comb. nov.

Gentiana primuliflora Franchet, Bull. Soc. Bot. France 31: 375. 1884.—TYPE: China, NW Yunnan, Dapintze [of Heqing]—Mochechin [of Eryuan], in grasslands, 3 Oct 1882, *Delavay Gent. n. 9* (holotype: P!; isotypes: E!, GH!, K!, UPS!).

Distribution. China (NW & C Yunnan, SW Sichuan). Grassland slopes, forests; 1,800–3,900 m.

9. *Metagentiana pterocalyx* (Franchet) T. N. Ho & S. W. Liu, comb. nov.

Gentiana pterocalyx Franchet in Forbes & Hemsley, J. Linn. Soc., Bot. 26: 132. 1890.—TYPE: China, NW Yunnan, Heqing (Hokin), 3,500 m, 18 Sep 1885, *Delavay 1553* (holotype: P!; isotypes: E!, GH!, IBSC!, K!).

Distribution. China (NW & NE Yunnan, SW Sichuan). Grassland slopes; 1,700–3,500 m.

10. *Metagentiana rhodantha* (Franchet) T. N. Ho & S. W. Liu, comb. nov.

Gentiana rhodantha Franchet in Forbes & Hemsley, J. Linn. Soc., Bot. 26: 133. 1890. Syntypes: China, Hubei (Hupeh), Ichang: *Maries s. n.* (K!), *Henry 964* (BM!, E!, GH!, IBSC!, K!, P!, PE!) & 2990 (K!, P!), 3986 (K!); NW Yunnan, [Heqing], Tapintze, 1,800 m, 15 Jun 1885, *Delavay 1869* (BM!, GH!, K!, P!, UPS!); Yunnan, without locality, May 1886, *Bourne s. n.* (K!). Lectotype (designated here): *Delavay 1869* (lectotype: P!; isolectotypes: BM!, K!, UPS!).

Gentiana jankae Kanitz, Pl. Exped. Szechenyi in As. Centr. Coll. 40. 1891.—TYPE: China, Yunnan, *Jankae 252* (not seen).

Gentiana rhodantha Franchet var. *wilsonii* Marquand, Bull. Misc. Inform. Kew 1928: 55. 1928.—TYPE: China, W Hubei (Hupeh), without precise locality or altitude, Nov 1907, *Wilson (Arn. Arb. Exped.) 2455* (holotype: K!; isotype: GH!).

Distribution. China (Yunnan, SW Sichuan, Guizhou, W Hubei, Henan, Gansu, S Shaanxi, Shanxi, Guangxi). Grasslands, scrub, forests; 500–2,000 m.

11. *Metagentiana serra* (Franchet) T. N. Ho, S. W. Liu & S. L. Chen, comb. nov.

Gentiana serra Franchet, Bull. Soc. Bot. France 31: 376. 1884.—TYPE: China, NW Yunnan, Dali (Tali)—Eryuan (Lan-kong), 6 Nov 1883, *Delavay Gent. n. 13* (holotype: P!; isotypes: GH!, K!).

Gentiana pulchra H. Smith in Handel-Mazzetti, Symbolae Sinicae 7: 951. 1936.—TYPE: China, NW Yunnan, Lijiang (Lidjiang), Jun–Sep 1914–1916, *Handel-Mazzetti 3751* (holotype: E!; isotype: UPS!). Paratypes: China, NW Yunnan, Lijiang (Lidjiang), 2,425–2,500 m, *Handel-Mazzetti 7011* (BM!, E!), 3473 (E!), *Forrest 2493* (BM!, E!); *ibid.*, 2,950–4,400? m, *Rock 5032* (E!, K!), 6174 (E!, IBSC!, K!, MO1, PE!, UPS!), 7788 (E!, IBSC!, K!, UPS!), 10715 (K1, MO1), 10748 (K1, PE!), 10839 (BM!, IBSC!, K!, P!), 10878 (IBSC!, K!).

Distribution. China (NW Yunnan). Meadows, forest margins, forests; 2,400–4,400 m.

Notes. *Gentiana serra* is a common species but easily confused with the other species of the genus. *Gentiana pulchra* was originally separated from *G. serra* supposedly by angular and unwinged seeds. However, the seeds of *G. serra* on the type specimen also are angular and almost unwinged. Actually, the seeds show variation from completely unwinged to narrowly winged on the angles in a number of gatherings we have seen.

12. *Metagentiana souliei* (Franchet) T. N. Ho, S. W. Liu & S. L. Chen, comb. nov.

Gentiana souliei Franchet, Bull. Soc. Bot. France 43: 491. 1896.—TYPE: China, W Sichuan (Se-tchuen), [Kangding], Tongolo and Tizou (Dzeura), Sep 1891, *Soulie 194* (holotype: P!; isotype: K!).

Gentiana pterocalyx Franchet var. *flavo-viridis* Marquand, Bull. Misc. Inform. Kew 1928: 54. 1928. *Gentiana souliei* Franchet var. *flavo-viridis* (Marquand) Marquand, Bull. Misc. Inform. Kew 1937: 154. 1937. Syntypes: China, NW Yunnan, Lijiang (Lichiang), 27°30' N, in open stony mountain pasture, 3,400 m, Sep 1910, *Forrest 6531* (BM!, E!, HNWP!, K!, MO1, PE!, UPS!); *ibid.*, in open woods, 3,800 m, 2 September 1914, *C. Schneider 2340* (BM!, E!, GH!, K!, P!); *ibid.*, in stony alpine meadows, 3,600 m, 4 Sep 1914, *C. Schneider 3135* (GH!, K!); Zhongdian (Chungtien), in alpine meadows, 3,600 m, 4 Sep 1914, *C. Schneider 3002* (GH!, K!). Lectotype (designated here): *Forrest 6531* (lectotype: E!; isolectotypes: E!, K!, UPS!).

Distribution. China (NW Yunnan, W Sichuan). Grassland slopes, stony slopes, alpine meadows, *Abies* forests; 3,200–3,900 m.

13. *Metagentiana striata* (Maximowicz) T. N. Ho, S. W. Liu & S. L. Chen, comb. nov.

Gentiana striata Maximowicz, Mém. Biol. Bull. Phys.-Math. Acad. Imp. Sci. St.-Petersbourg 11: 265. 1881; Bull. Acad. Imp. Sci. St.-Petersbourg 27: 501. 1881.—TYPE: China, W Gansu (Kansu), in alpine meadows, in 1872, *Przewalski s. n.* (holotype: LE, not seen).

Gentiana tricholoba Franchet, Bull. Soc. Bot. France 43: 490. 1896.—TYPE: China, [W Sichuan], Kanding (Ta tsien lou), *Soulie 134* (holotype: P!).

Gentiana schlechteriana Limpricht, Repert. Spec. Nov. Regni Veg., Beih. 12: 467. 1922.—TYPE: China, W Sichuan (as Ost.-Tibet), Kangding (Ta-tsien-lou), 3,900 m, *Limpricht 1768* (holotype: WRSL, not seen; isotype: UPS!).

Distribution. China (E Xizang, W Sichuan, Qinghai, Gansu, Ningxia). Grassland slopes, alpine meadows, scrub; 2,200-3,900 m.

14. *Metagentiana villifera* (H. W. Li ex T. N. Ho) T. N. Ho & S. W. Liu, comb. nov.

Gentiana villifera H. W. Li ex T. N. Ho, Bull. Bot. Res., Harbin 4(1): 75, t. 2. January 1984; H. W. Li & C. Y. Wu, Acta Phytotax. Sin. 22(2): 156. April 1984.—TYPE: China, SE Sichuan, Junlian, on rocks in a valley, 800 m, 19 Apr 1959, *Sichuan Econ. Pl. Exped. Yibin Sect. 18* (holotype: CDBI!; isotypes: KUN!, PE!, SZ!).

Distribution. China (SE Sichuan). Valleys; ca. 800 m.

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龍膽科一新屬：狹蕊龍膽屬

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外部形態學、花部解剖學、細胞學、花粉形態和胚胎學的綜合分析結果表明龍膽屬狹蕊組在該屬內非常特殊，正如不同於其他屬、如雙蝴蝶屬 (*Tripterospermum*) 和蔓龍膽屬 (*Crawfordia*) 一樣不同於該屬其他組，故狹蕊組應從龍膽屬內分離出去作為一個獨立的屬。我們把它命名為狹蕊龍膽屬 (*Metagentiana*)。新屬與雙蝴蝶屬 (*Tripterospermum*) 和蔓龍膽屬 (*Crawfordia*) 的親緣關係最近，三者構成了一個單系群而成為龍膽屬的姐妹群。另外，本文還進行了14個種的新組合。

關鍵詞：狹蕊龍膽屬；龍膽屬；龍膽科；新屬；分類學。