

Taxonomic study of some medicinally important species of *Swertia* L. (Gentianaceae) in Nepal

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Abstract

Among 100 species of *Swertia* reported from the world, Nepal harbors 30 species along with four varieties. In Nepal, species of *Swertia* are highly exploited as raw materials for different traditional medicines. Among them, *S. chirayita*, a vulnerable species, has been considered to be superior in medicine and trade. One of the main issues in its trade is adulteration with other species which are considered to be inferior in medicinal quality. Species which are mixed with *S. chirayita* are *S. angustifolia*, *S. ciliata*, *S. dilatata*, *S. paniculata*, *S. racemosa*, etc. There is a need for the selection of most important morphological characteristics for instant identification of different species of *Swertia* to check illegal trade as well as adulteration. This paper aims to provide the most important identifying characters of eight species of *Swertia* traded from Nepal on the basis of their morphological studies. Color of the petal, number of floral parts (tetramerous vs. pentamerous) and number of glands in petal are the key characters for the identification of the species.

Key-words: adulteration, medicinal plant, morphological characters.

Introduction

Gentianaceae is a family of 84 genera and about 970 species in the world (Judd *et al.* 1999). Members of the family are widely distributed, but are most diverse in temperate and subtropical regions and in the montane tropics. Clarke (1885) divided Gentianaceae into three tribes: Exaceae, Chironeae and Swertiaeae. Cronquist (1988) treated the family under order Gentianales of subclass Asteridae and class Magnoliopsida. Judd *et al.* (1999) treated the family under order Gentianales and clade Core asterids.

Swertia is named in honor of Emanuel Sweert (rarely spelled Swert, 1552-1612), a Dutch gardener. Clarke (1885) divided *Swertia* into three subgenera: *Ophelia*, *Euswertia* and *Poephila*. A total of 29 species of *Swertia* have been reported from Nepal (Press *et al.*, 2000; DPR, 2001). However, the number reached to 30 as Chassot (2003) recently reported *Swertia barunensis* from east Nepal.

Nepalese species of *Swertia* are distributed from east to west and from tropical to alpine zone. Distribution ranges from 600 m asl (*S. angustifolia*) to 5600 m asl (*S. petiolata*). Certain species, like *S. angustifolia*, *S. chirayita* and *S. multicaulis* are highly exploited as raw materials for different medicines. However, *S. chirayita* plays dominant role in trade and is considered to be superior in medicinal quality. Due to high commercial demand, *S. chirayita* has vulnerable status in Nepal and India. One of the main issues in its trade is adulteration with other low-value species considered to be inferior in medicinal quality (Ghimire *et al.* 2008). *Swertia nervosa* is the main substitute of *S. chirayita* in trade (Pant and Bimb 2005). Other species which are generally mixed with *S. chirayita* are *S. angustifolia*, *S. ciliata*, *S. dilatata*, *S. paniculata*, *S. racemosa*, etc. (Bhattarai and Acharya 1998; Ghimire *et al.* 2008). Sometimes adulteration occurs due to misidentification of the true species.

Taxonomically *Swertia* is a difficult genus. Morphological characters are the main basis for the identification and delimitation of taxa within *Swertia*. Most importantly there is a need for the selection of pertinent morphological characteristics for instant identification of different species of *Swertia* involved in trade which will help to check illegal trade as well as adulteration. This paper aims to provide the most important identifying characters of eight species of *Swertia* traded from Nepal.

Materials and Methods

The present study was based on the herbarium specimens deposited at Tribhuvan University Central Herbarium (TUCH) and some specimens collected by the author. The vegetative and reproductive parts of the specimens were examined. Identity of the species was confirmed based on the specimens deposited at National Herbarium and Plant Laboratory (KATH), and following standard literature (Zheng-yi and Raven 1995; Grierson and Long 1999).

Results

TAXONOMIC TREATMENT

Swertia L.

Members of the genus are annual, biennial or perennial herb. Roots fibrous or woody. Stems absent, scapiform, or well developed, ascending or erect, terete, striate or angled or winged, simple or branched. Leaves opposite, rarely alternate or whorled or rosulate, sessile or petiolate, margin entire. Inflorescence cymose, usually grouped into simple or paniculate thyrses, rarely strictly dichoto-

mous, sometimes reduced to single flowers and inflorescences raceme-like or flowers solitary and terminal. Flowers pedicellate, 4- or 5-merous. Bracts leaf-like, opposite, sessile. Calyx and corolla rotate, lobed to base, tubes less than 3 mm. Nectaries 1 or 2 per corolla lobe, naked or covered by a scale or flaps, glabrous, fringed or fimbriate. Stamens as many as corolla lobes, attached at base of corolla lobe sinuses, sometimes surrounded by long hairs. Ovary 1-celled. Style short to elongate. Stigma bilobed. Fruit a capsule, enclosed by persistent calyx and corolla, ovoid or flattened, dehiscent into 2 valves, few to many seeded. Seeds small.

KEY TO THE SPECIES

1a. Flowers 4-merous

- 2a. Glands 2 per corolla..... 2. *S. chirayita*
 2b. Gland 1 per corolla
 3a. Corolla white or pale yellow with brown spots.. 1. *S. angustifolia*
 3b. Corolla pale yellow-green or whitish with purple nerves
 6. *S. nervosa*

1b. Flowers 5-merous

- 4a. Glands 2 per corolla, plant non-ciliated 4. *S. cuneata*
 4b. Gland 1 per corolla, cilia in leaf margin or sepal or petal
 5a. Filament dilated up to the half, 2 greenish spots above each gland in each petal 5. *S. dilatata*
 5b. Filament not dilated, greenish spots absent
 6a. Glands linear, covered by fimbriated flap, cilia present in sepal and petal 8. *S. racemosa*
 6b. Glands horse-shoe-shaped, covered by non-fimbriated flap, cilia absent in sepal and petal
 7a. Corolla reflexed at anthesis, purple band or spots above each gland, no flap and fimbria on gland 3. *S. ciliata*
 7b. Corolla not reflexed, 2 blackish spots above each gland, yellow non-fimbriated flap on gland 7. *S. paniculata*

1. *Swertia angustifolia* D. Don, Prodr. Fl. Nepal.: 127 (1825). Clarke in Fl. Br. India 4 (10): 125 (1883). Chatter in Enum. Fl. Pl. Nepal 3: 96 (1982). Malla *et al.*, Fl. Kath. Valley: 483 (1986). Tingnung & Pringle in Fl. China 16: 116 (1995). Aitken in Fl. Bhutan 2 (2): 626 (1999). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 117(2000).

Ophelia angustifolia (Buch.-Ham. ex D. Don) G. Don, Gen. Syst. 4: 178 (1837).

Chiraito

Annual herb, 20-80 cm. Stem erect, hollow, quadrangular, glabrous. Leaves subsessile, leaf blade linear to narrow lanceolate, 2-5.5 × 0.2-1.7 cm, base attenuate, margin entire, apex acute, veins 1-3. Inflorescence many flowered panicles. Pedicel 0.6-2.3 cm. Bracts linear or lanceolate, 2.3-1.0 cm × 1.0-2.0 mm. Flowers 4-merous. Calyx green, tube 0.5 mm, lobes linear or lanceolate, 0.8-1.4 cm × 1-2 mm, 3-nerved. Corolla white or pale yellow, with brown spots, tube 1 mm, lobes elliptic or ovate, 5-7 × 2-4 mm, gland 1, pocket-shaped, orbicular scale with short fimbriae. Stamens 4, filaments 2.5 mm, anther 1 mm. Carpel 1.5-7 mm. Capsule 0.5 mm. Fl. & Fr. Aug.-Nov. (Fig. 1).

Distribution: Nepal (WCE, 235-2600 m), Himalaya (Kashmir to Bhutan), N. India, Myanmar, S. China.

Specimens examined: Sindhuli: Napani, 1240 m, 27 Nov. 1988, N.P. Manandhar 12637 (KATH). Ramechhap: Kangba gaon, 1850 m, 13 Aug. 1977, K.R. Rajbhandary and B. Roy 2245 (KATH). Kathmandu: Putalidanda, 1800 m, 7 Jan. 1975, Joshi *et al.* 75/134 (KATH); Chobhar, 27 Apr. 2003, R. Upreti 2 (TUCH); Chobhar, 10 Oct. 2001, B. Raskoti 10 (TUCH). Rasuwa: Syabru bensi, 1450 m, 5 Sept. 1971, J.F. Dobremez 961 (KATH). Dhading: Todaki, 1150 m, 8 Nov. 1989, N.P. Manandhar 13172 (KATH). Chitwan: Tiger Top, 300 m, 12 Dec. 1975, D.P. Joshi *et al.* 75/3498 (KATH). Myagdi: Dana, 1470 m, 30 Aug. 1983, N.P. Manandhar 10282 (KATH); Tripling, 1050 m, 1 Oct. 1985, D.P. Joshi *et al.* Gulmi: Kudapani, 1 June 2003, K.C. Bishnumaya 62 (TUCH). Palpa: Chilaune danda, 26 Jestha 2058, G. Shreshtha 69 (TUCH). Syangja: Bayar Ghari, 10 June 2001, Do35 (TUCH). Kanchanpur: Suklaphanta, 235 m, 28 March 1984, P. Pradhan and R.K. Uprety 978 (KATH). Kalikot: Takula, 1600 m, 14 Aug. 1981, N.P. Manandhar and D.P. Joshi 8263 (KATH). Doti: Jhigadana-Choyagadru, 2500 m, N.K. Bhattarai 90/762 (KATH). Dailekh: Chhanna, 2000 m, N.P. Manandhar and D.P. Joshi 8227 (KATH). Rolpa: Budhogam, 1313 m, 5 Sept. 1982, N.P. Manandhar and N.K. Bhattarai 8809 (KATH).

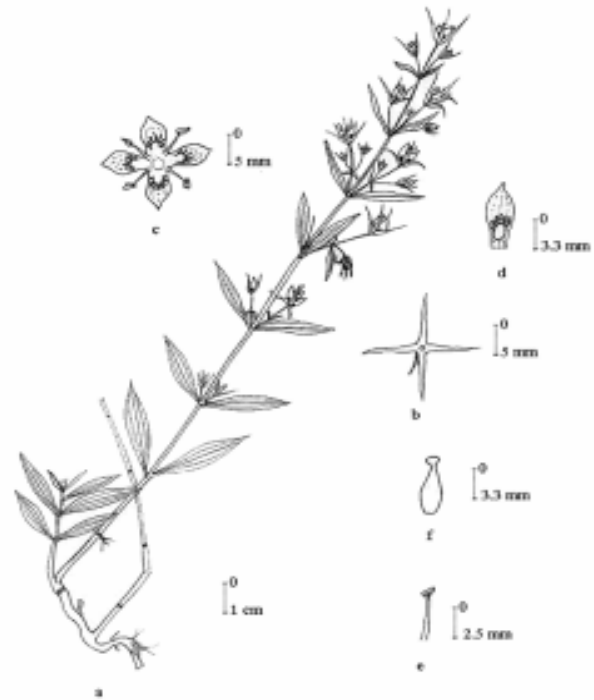


Fig. 1. *Swertia angustifolia* D. Don: (a) habit, (b) calyx, (c) corolla, (d) petal with nectary, (e) stamen, (f) carpel (Raskoti 10, TUCH).

2. *Swertia chirayita* (Roxb. ex Fleming) H. Karst., Deut. Fl. (Karsten): 1025 (1883). Clarke in Fl. Br. India: 4 (10): 124 (1883). Chatter in Enum. Fl. Pl. Nepal 3: 96 (1982). Malla *et al.*, Fl. Kath. Valley: 483 (1986). Aitken in Fl. Bhutan 2 (2): 626 (1999). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 118 (2000).

Swertia chirata (Wall.) C. B. Clarke in Fl. Br. India: 4: 124 (1883).

Chiraito

Annual or biennial herb up to 90 cm. Stem erect, hollow, terete, glabrous. Leaves sessile, leaf blade ovate or elliptic, 1.6-10.2 × 0.6-4.0 cm, amplexicaul or clasping, margin entire, apex acute. Inflorescence panicles of cymes. Flowers 4-merous. Pedicels 0.4-

0.6 cm. Bracts elliptic-ovate, 0.5-1.0 cm × 1-3 mm. Calyx greenish yellow, tube 0.5-1.0 mm, lobes linear lanceolate, 4-6 × 0.5-1.0 mm. Corolla greenish yellow, tube 1-2 mm, lobes ovate, 4-6.5 × 2-3 mm, glands 2 per corolla lobe, oval or oblong, fimbriate. Stamens 4, haplostemonous, filament 3-4 mm, anthers 0.5-1.0 mm. Carpel 3-5 mm; stigma lobe capitate. Capsule 0.5-0.6 cm. Fl. & Fr. Sept.-Nov. (Fig. 2).

Distribution: Nepal (CE, 1500-2500 m), Himalaya (Kashmir to Bhutan), NE India.

Specimens examined: Taplejung: Change-8, 2100 m, 13 Oct. 2002, P. Paudel 101d (TUCH); Ghunsa khola, 2500 m, 5 Sept. 1989, C. Grey-Wilson *et al.* 243 (KATH); Hurure-Mure, 31 Aug. 1986, T.B. Shreshtha and P.R. Shakya 8908 (KATH); Khapare, 25 Bhadra 2037, I. Shreshtha and T.M. Shrestha 33 (KATH). Dolakha: Dusikharka, 2400 m, 4 July 1990, N.K. Bhattarai 90/417 (KATH). Sindhupalchok: Kakani, 2000 m, 3 Nov. 1985, N.K. Bhattarai 85/827 (KATH). Kathmandu: Manichur, 1900 m, 15 Sept. 2000, G. Dongol 15 (TUCH); Nagarjun, 1676 m, 19 Oct. 1964, Bista *et al.* 9655 (KATH). Lalitpur: Phulchowki, 1750 m, 10 Aswin 2055, N. Thapa 45 (TUCH). Gorkha: S-facing, 2740 m, 2 Oct. 1995, Olsen 355 (KATH). Kaski: Dhampus, 1650 m, 21 May 1992, N.P. Manandhar and S.K. Acharya 28-92 (KATH). Jumla: Rara, 2900 m, 10 Aug. 1981, N.P. Manandhar and D.P. Joshi 8123 (KATH). Doti: Khaptad, 3200 m, 12 Sept. 1983, L.R. Sharma and Kurmi 57/11 (KATH).

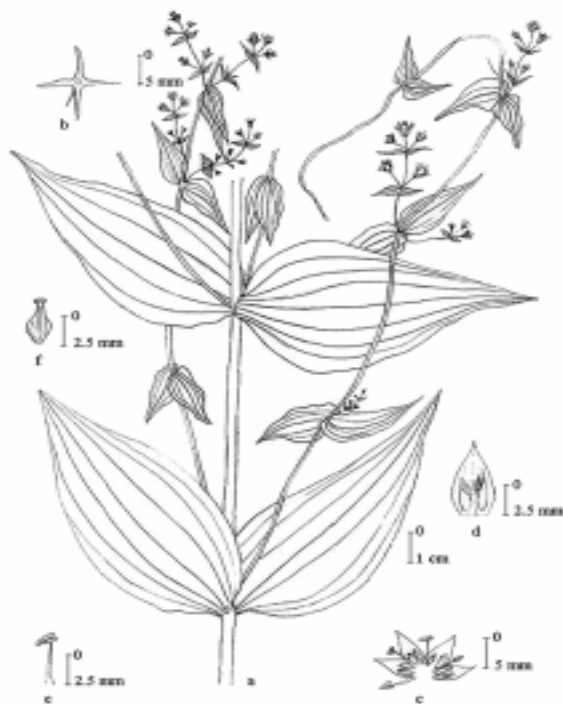


Fig 2. *Swertia chirayita* (Roxb. ex Fleming) H. Karst. (a) habit, (b) calyx, (c) corolla, (d) petal with nectarines, (e) stamen, (f) carpel (Paudel 101d, TUCH).

3. *Swertia ciliata* (D. Don ex G. Don) B.L. Burtt, Notes Roy. Bot. Gard. Edinburgh 26: 272 (1965). Chater in Enum. Fl. Pl. Nepal 3: 96 (1982). Malla *et al.*, Fl. Kath. Valley: 483 (1986). Ting-nung and Pringle in Fl. China 16: 122 (1995). Aitken in Fl. Bhutan 2 (2): 623 (1999). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 118 (2000).

Ophelia ciliata D. Don ex G. Don, Gen. Syst. 4: 178 (1837).

Kalen

Annual herb up to 50 cm. Stem erect, hollow, glabrous, branched. Leaves sessile or short petiolate, leaf blade lanceolate to ovate-lanceolate, 0.8-3.5 × 0.2-0.6 cm, base obtuse, margin slightly revolute, apex acute, veins 3. Inflorescence panicles of cymes. Flowers 5-merous. Pedicel 0.4-2.0 cm. Bracts lanceolate, 1-2 cm × 2-4 mm. Calyx green, tube 1-2 mm, lobes reflexed at anthesis, lanceolate, 0.5-0.6 cm × 1.5-2.0 mm, apex acuminate. Corolla pale blue or bluish white, with purple band above gland in each petal; tube 1.0-1.5 mm, lobes spreading at anthesis, ovate-lanceolate, 4 × 2 mm, apex acuminate. Nectary 1 per corolla lobe, horse-shoe-shaped, naked. Stamens 5, haplo-stemonous; filaments dark purple, 3.5-5.5 mm, connate at the base around ovary forming a rim or tube, tube 1.5-2.0 mm, anthers blue purple, 1.0 × 0.5 mm. Carpel 1.5-5 mm, style 1-2 mm, stigmas capitate. Capsule 7-9 mm. Fl. & Fr. Jul.-Sept. (Fig. 3).

Distribution: Nepal (WCE, 1700-4000 m), Afghanistan, Himalaya (Kashmir to Sikkim).

Specimens examined: East Nepal: between Basantpur and Doorpani, 2690 m, C. Grey-Wilson 50 (KATH). Central Nepal: Deurali-Chitre, 2300-2960 m, 17 Sept. 1985, N. Dabadi *et al.* 67/85 (KATH). Gorkha: Ghyalchok, 3600 m, 18 Sept. 1995, Olsen 337 (KATH). Manang: between Gunsang and Yak Kharka, 3900 m, Sept. 2005, D.P. Rijal 125M (TUCH). Jumla: 2800 m,

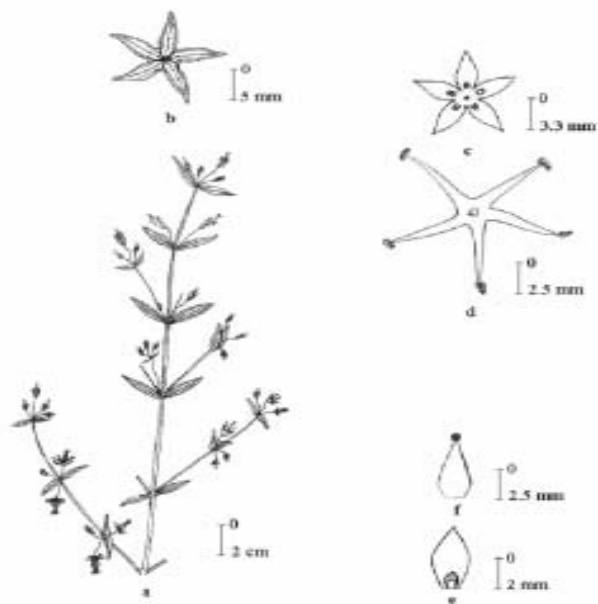


Fig. 3. *Swertia ciliata* (D. Don ex G. Don) B.L. Burtt. (a) habit, (b) calyx, (c) corolla, (d) androecium, (e) petal with nectary, (f) carpel (Rijal 125M, TUCH).

6 Sept. 1973, Einemon *et al.* 3871 (KATH). Doti: Khaptad, 3200 m, 2 Sept. 1984, L.R. Sharma and P.P. Kurmi 4295 (KATH).

4. *Swertia cuneata* D. Don, London Edinb. Philos. Mag. J. Sci. 8: 77 (1836). Clarke in Fl. Br. India: 4 (10): 129 (1883). Chater in Enum. Fl. Pl. Nepal 3: 96 (1982). Ting-nung and Pringle in Fl. China 16: 109 (1995). Aitken in Fl. Bhutan 2 (2): 628 (1999). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 118 (2000).

Perennial herb 9-60 cm. Stem erect, hollow, glabrous; base sheathed by blackish remains of old petioles. Leaves mostly basal, whorled; petiole winged, up to 2.3 cm, leaf blade spatulate-obovate, 1.0-5.0 × 0.5-1.0 cm, base attenuate, margin entire, apex rounded or acute. Stem leaves 2 or 3 pairs, sessile or short petiolate, petiole 1-2 cm, leaf blade narrowly elliptic, 4.0-5.0 × 1.0 cm, veins 3-7. Inflorescence panicles of cymes. Flowers 5-merous. Bracts linear or narrowly oblong, 2-3.5 × 0.2-0.7 cm. Pedicel 1.3-5.5 cm. Calyx tube 1.0-1.5 mm, lobes oblong-spatulate to elliptic, 4.5-10 mm. Corolla blue or pale-blue or dull purple, tube 2.0 mm, lobes narrowly elliptic or ovate, hairy at base, 1.7 × 0.6 cm, veins 5-7. Nectaries 2 per corolla lobe, linear, fimbriate, fimbriae up to 4 mm. Stamens 5, haplostemonous; filaments 0.9-1.0 cm, anthers blue, 3 mm, versatile. Carpel 1-2 cm, style indistinct, stigma bilobed. Capsule 1.8-2 cm. Fl. & Fr. Aug.-Oct. (Fig. 4).

Distribution: Nepal (WCE, 3900-5000 m), Himalaya (Uttar Pradesh to Sikkim), NE India, China (Xizang).

Specimens examined: Rasuwa: Lawri Binayak, 4200 m, 26 Aug. 1969, Malla 16201 (KATH); Ghopte to Gosaithan, 4267 m, 9 Sept. 1965, T.B. Shrestha 3741 (KATH). Manang: Chhonkar, 4300 m, Sept. 2005, D.P. Rijal 150M (TUCH). Jangla Bhanjyang, 4267 m, 15 Aug. 1973, Einemon *et al.* 3242 (KATH).

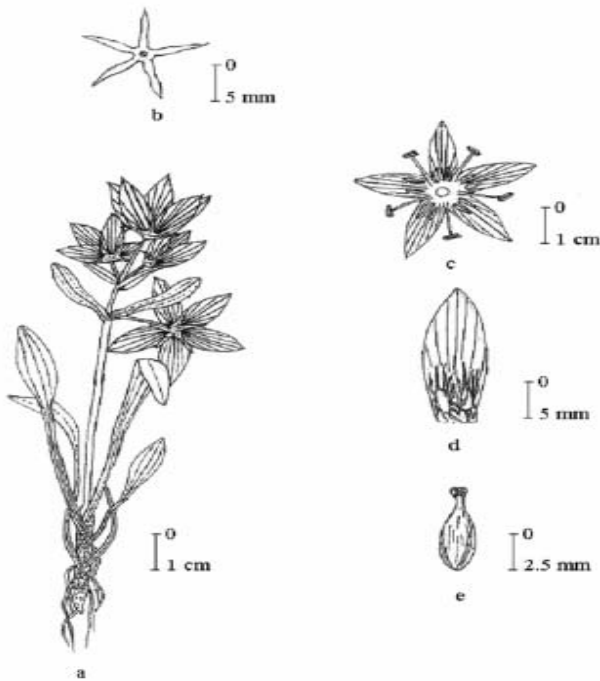


Fig. 4. *Swertia cuneata* D. Don (a) habit, (b) calyx, (c) corolla and androecium, (d) petal with nectarines, (e) carpel (Rijal 150M, TUCH).

5. *Swertia dilatata* var. *pilosa* C.B. Clarke, Fl. Br. India: 4(10): 122 (1883). Chater in Enum. Fl. Pl. Nepal 3: 96 (1982). Malla *et al.*, Fl. Kath. Valley: 484 (1986). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 118 (2000).

Swertia dilatata Malla *et al.*, Fl. Kath. Valley: 484 (1986).

Herb up to 50 cm. Stem erect, hollow, terete at base and cylindrical above, glabrous. Leaves sessile, leaf blade linear or narrowly elliptic-lanceolate, recurved downwards, 1.8-4.0 cm × 2-4

mm, base minutely ciliate and attenuate, margin entire, apex acute. Inflorescence panicles of cymes. Flowers 5-merous. Pedicel 0.3-1.5 cm. Bracts elliptic lanceolate, 1.6-3.0 × 0.2-0.4 cm. Calyx green, tube 1.0-1.5 mm, lobe ovate or lanceolate, 6.5-7.5 × 4.0-5.0 mm. Nectary 1 in each corolla lobe, horse-shoe-shaped, flap without fimbria. Stamens 5, haplostemonous, filament much dilated for more than half their length, 4-5 mm, anthers 1.0 × 0.5 mm. Capsule 8 × 2.5 mm. Fl. & Fr. Sept.-Nov. (Fig. 5).

Distribution: Nepal (WCE, 1400-4100 m).

Specimens examined: East Nepal: Murhay-Chitre, 24 Oct. 1963, H. Hara *et al.* 6302545 (KATH). Phidim: Inthung, 2400 m, 19 Nov. 1978, P. Pradhan *et al.* 1071 (KATH). Sankhuwasabha: Chauki, 2690 m, 12 Oct. 2002, P. Paudel 101e (TUCH). Kathmandu: Manichur, 2030 m, 6 Sept. 2000, S. Marasani 46 (TUCH). Myagdi: Tadopani, 2700 m, Oct. 1999, Sita and Puspa sp169 (TUCH). Baglung: Lephane, 2300 m, 11 Aswin 2056, P. Sapkota 5 (TUCH). Jumla: 4115 m, 23 Sept. 1983, N.P. Manandhar 9042 (KATH). Surkhet: Goganpani, 1460 m, 8 Dec. 1982, S.R. Adhikari and N.P. Manandhar 9198 (KATH). Bajhang: Jhogan danda, 2250 m, 27 Aug. 1972, M.S. Bista and D.P. Joshi 757 (KATH).

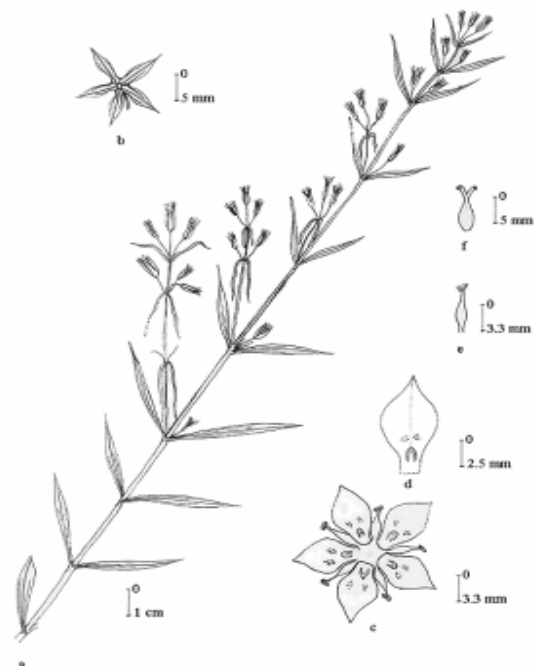


Fig. 5. *Swertia dilatata* var. *pilosa* C.B. Clarke (a) habit, (b) calyx, (c) corolla, (d) petal with nectary, (e) stamen, (f) capsule (Marasani 46, TUCH).

6. *Swertia nervosa* (G. Don) C. B. Clarke, Fl. Br. India: 4 (10): 125 (1883). Chater in Enum. Fl. Pl. Nepal 3: 97 (1982). Malla *et al.*, Fl. Kath. Valley: 484 (1986). Ting-nung and Pringle in Fl. China 16: 116 (1995). Aitken in Fl. Bhutan 2 (2): 626 (1999). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 118 (2000).

Ophelia nervosa (G. Don) Griseb., Gen. Sp. Syst. 317 (1838).

Kalochiraito

Annual herb up to 100 cm. Stem erect, hollow, sub-quadrangular, glabrous, winged. Leaves sessile or sub-sessile, leaf blade elliptic to lanceolate, 2.4-7.1 × 0.4-1.8 cm, base attenuate, margin entire, apex acute, veins 1-3. Inflorescence panicles of cymes. Pedicel 0.5-2.0 cm. Bracts linear or lanceolate, 1.3-2.5 cm × 2-4 mm. Flowers 4-merous. Calyx green, tube 0.5-1.0 mm, lobes linear-lanceolate, 1.0-1.3 cm × 1-2 mm. Corolla pale yellow-green or whitish, with purple veins, tube 1-2 mm, lobes elliptic-ovate, 0.7-0.8 cm × 2-3 mm. Nectary 1 per corolla lobe, with pocket-like flap, fimbriate at apex. Stamens 4, haplostemonous, filament 4.5-6.0 mm; anthers 1 mm. Carpel 0.7-0.8 cm; ovary ovoid, style short, stigma lobe capitate. Capsule 0.5 cm. Fl. & Fr. Aug.-Nov. (Fig. 6).

Distribution: Nepal (WCE, 700-3200 m), Himalaya (Himanchal Pradesh to Bhutan), NE India (Assam, Nagaland), W. China.

Specimens examined: Terhathum: Shreemane, 2690 m, 12 Oct. 2002, P. Paudel 101d (TUCH). Sindhupalchowk: south of Ganja pass, 4000 m, 26 Sept. 1966, D.H. Nicolson 2647 (KATH). Katmandu: Sundarijal, 16 Feb. 2001, B. Adhikari 152 (TUCH). Lalitpur: Phulchowki, 1600 m, 16 Shrawan 2056, M. Thapa (TUCH). Baglung: Dhapharkhet, 2300 m, 8 Sept. 1991, N.P. Manandhar 944-91 (KATH). Mustang: Muktinath, 3453 m, 23 Sept. 1985, D.P. Joshi and N.K. Bhattarai 166/85 (KATH). Mugu: Gamgarhi, 3200 m, 10 Aug. 1981, N.P. Manandhar and D.P. Joshi 6981 (KATH); Rara National Park, 3200 m, 26 Nov. 1995, P.P. Kurmi and N. Thapa 7468 (KATH). Jajarkot: Samaila, 2130 m, 17 Sept. 1982, N.P. Manandhar 8955 (KATH).

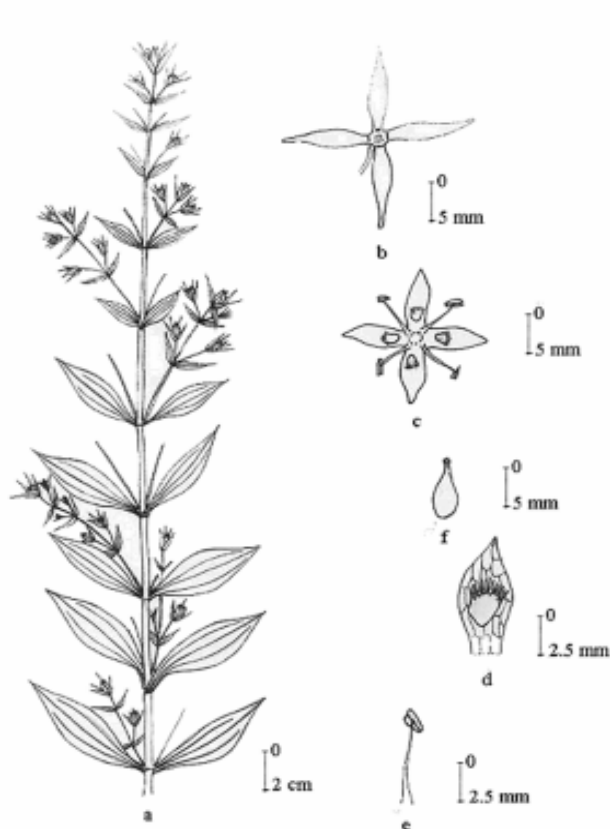


Fig. 6. *Swertia nervosa* (G. Don) C. B. Clarke (a) habit, (b) calyx, (c) corolla, (d) petal with nectary, (e) stamen, (f) carpel (Paudel 101d, TUCH).

7. *Swertia paniculata* Wall., Pl. Asiat. Rar. 3 (9): 3, t. 205 (1831). Clarke in Fl. Br. India: 4(10): 122 (1883). Chatter in Enum. Fl. Pl. Nepal 3: 97 (1982). Ting-ning and Pringle in Fl. China 16: 123 (1995). Aitken in Fl. Bhutan 2 (2): 624 (1999). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 118 (2000).

Ophelia paniculata (Wall.) D. Don in Tr. Linn. S. 17: 525 (1837).

Annual herb, 80-120 cm. Stem erect, hollow, terete, glabrous. Leaves sessile, blade linear, 1.0-2.5 cm × 1-3 mm, base attenuate, margin entire, apex acuminate, veins 1-3. Inflorescence axillary and terminal, panicles of cymes. Pedicels 0.3-1.0 cm. Bracts linear lanceolate, 0.5-1.1 cm × 0.5-1.0 mm. Calyx tube 0.5 mm, lobes lanceolate, 4 × 1 mm, 3-nerved. Corolla pale yellow; tube 1 mm, lobes elliptic-ovate, 5 × 2.5 mm, twisted. Nectary 1 per corolla lobe, horse-shoe-shaped, opening towards base, non-fimbriated yellowish flap. Stamens 5, haplostemonous, filament 2.5 mm, anther 1 mm. Carpel 4 × 1 mm. Fl. & Fr. Aug.-Sept. (Fig. 7).

Distribution: Nepal (WCE, 1500-4000 m), Himalaya (Kashmir to Bhutan), NE India, Myanmar, China (Xizang).

Specimens examined: Way to Tatopani, 2395 m, 28 Sept. 1994, Y. Piya 60 (TUCH). Khapare, 25 Bhadra 2037, I. Shrestha and T.H. Shrestha 14 (KATH). Makawanpur: Shimshanjiang, 2438 m, Oct. 1960, S.B. Shah 17 (KATH). Sangasoti Bangtholi, 2316 m, 8 Oct 1960, S.B. Malla and S.B. Rajbhandary 349 (KATH). Mustang: Lete-Larjung Cobang, 2280-2480 m, 20 Sept. 1985, N. Dabadi and N. Pradhan 134a (KATH). Jharkot, 3300 m, 17 Aswin 2051, M.K. Bhandari 48 (TUCH).

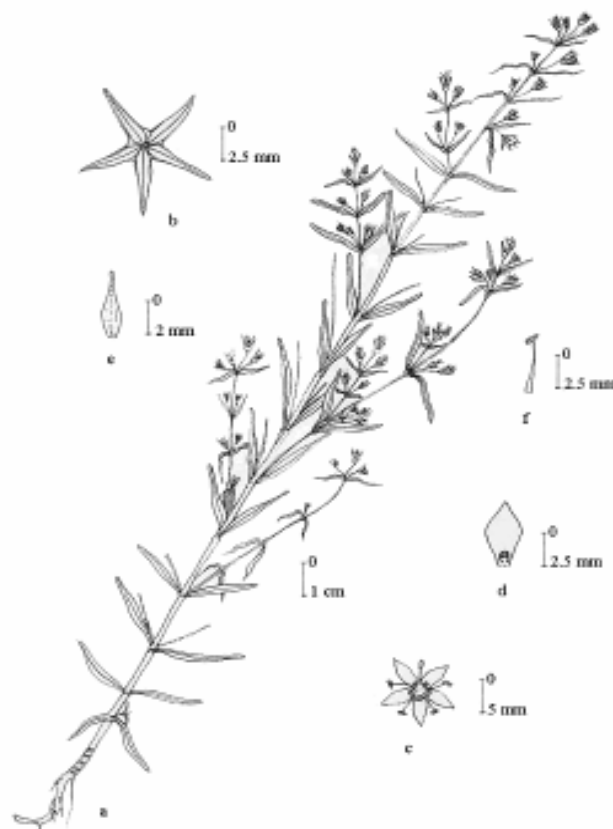


Fig. 7. *Swertia paniculata* Wall. (a) habit, (b) calyx, (c) corolla, (d) petal with nectary, (e) carpel, (f) stamen (Bhandari 48, TUCH).

8. *Swertia racemosa* (Griseb.) C. B. Clarke, Fl. Br. India: 4 (10): 124 (1883). Chatter in Enum. Fl. Pl. Nepal 3: 97 (1982). Ting-nung and Pringle in Fl. China 16: 123 (1995). Aitken in Fl. Bhutan 2 (2): 625(1999). Press *et al.*, Ann. Check. Fl. Pl. Nepal: 118 (2000).

Ophelia racemosa Griseb., Gen. Sp. Gent. 319 (1838).

Herb, 3-40 cm. Stem erect, hollow, terete, glabrous. Leaves sessile, blade lanceolate, 1.5-4.0 × 0.6-1.2 cm, base auriculate and sub-amplexicaul, margin entire, ciliate, apex acute, veins 1-3. Inflorescence panicles of cymes, many flowered, spreading. Pedicel 0.8-2.0 cm. Flowers 5-merous. Calyx green, tube campanulate, 3-4 mm, lobes triangular lanceolate, margin ciliate, 3.5-5 mm. Corolla pale blue to pale blue-purple, tube campanulate, 9 mm, lobe 3-6 mm, margin ciliate. Nectary 1 in each petal, linear, fimbriate, opening towards the base. Stamens 5, haplostemonous, filament basally white, apically blue, 5-7 mm, basally much enlarged and connate, anthers blue. Capsule 0.7-1.5 cm. Fl. & Fr. Aug.-Sept. (Fig. 8).

Distribution: Nepal (WCE, 1700-5000 m), Himalaya (Nepal to Bhutan), NE India, China (Xizang).

Specimens examined: Sindhupalchowk: south of Ganja pass, 4000 m, 26 Sept. 1966, D.H. Nicolson 2647 (KATH). Kathmandu: Sundarimal, 1700 m, 1 Jestha 2057, S. Gautam 53 (TUCH). Rasuwa: Langtang, April 1999, A. Pokhrel and G. Rana AG248 (TUCH). Manang: Way to Tilicho, 4000 m, Sept. 2005, D.P. Rijal 115M (TUCH). Mustang: Muktinath, 3795 m, 25 Sept. 2003, B. Dewan 144 (TUCH). Baglung: Jaljala to Gurjaghat, 3480-3018 m, 10 June 1985, D.P. Joshi *et al.* 212/85 (KATH). Dhorpatan, 2896 m, 16 Oct. 1954, Stainton *et al.* 9056 (KATH). Mugu: Rara, 10 Aug. 1981, N. Dabadi and N. Pradhan 8084 (KATH).

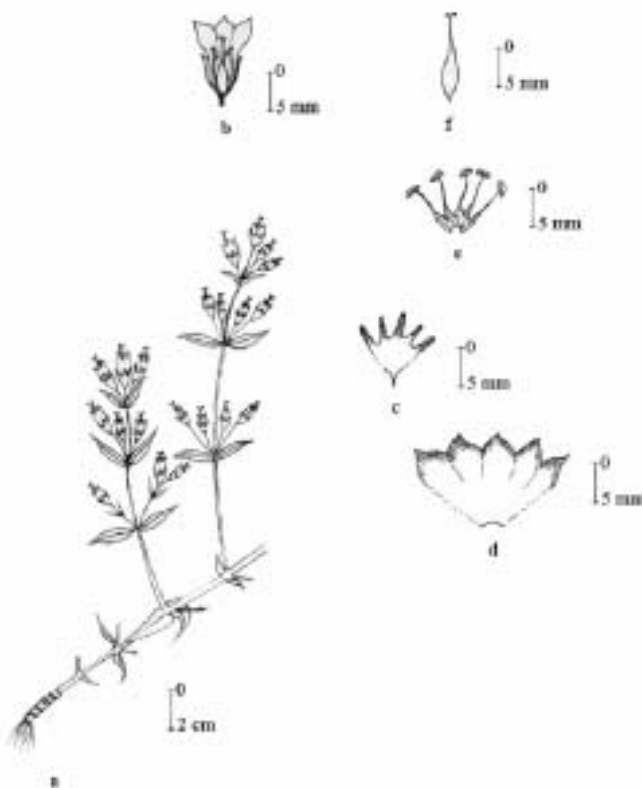


Fig. 8. *Swertia racemosa* (Griseb.) C.B. Clarke (a) habit, (b) l.s. of flower, (c) calyx, (d) corolla, (e) stamen, (f) carpel (Gautam 53, TUCH).

Discussion

The present study was based on only eight species of *Swertia* (*S. angustifolia*, *S. chirayita*, *S. ciliata*, *S. cuneata*, *S. dilatata*, *S. nervosa*, *S. paniculata*, and *S. racemosa*) out of a total of 30 species so far recorded from Nepal. All the specimens included in this study are distributed from west to east Nepal. Lack of sufficient herbarium specimen was the main factor behind the study of only eight species of *Swertia*. However, important and confusing species, which are commonly adulterated with *S. chirayita* in trade, have been included. This study has identified some important morphological characters to distinguish these species. The present study also provides the basic information for the detailed study of the genus *Swertia* in future.

Petal color, number of floral parts (tetramerous vs. pentamerous), number of nectaries (glands) in petal (1 or 2), characteristics of flap (presence or absence and either fimbriated or non-fimbriated), and presence or absence of cilia are the key characters for the delimitation of the species of *Swertia*. These characteristics must be considered for correct identification of the species commonly adulterated with *S. chirayita*. Furthermore, the presence of cilia or papillae is quite prominent in *S. ciliata* and not distinct in all other species. Out of the three tetramerous species studied, only *S. chirayita* contains two glands. Among the pentamerous species, *S. cuneata* contains two glands. *S. cuneata* and *S. racemosa* contain fimbriated flap on the gland. Presence of two green spots above each gland is prominent only in *S. dilatata*. The later species is further differentiated from all other species based on the presence of distinctly dilated filaments.

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