

ANATOMY AND MORPHOLOGY OF THE GENUS *HOPPEA* WILLD. (GENTIANACEAE)

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ABSTRACT: *Hoppea* (Gentianaceae) is represented by two species in the world, both occur in India. Since scanty information is available for these species, detailed morphology and anatomy are provided here to facilitate easy identification.

Keywords: *Hoppea*, Gentianaceae, Canscorinae.

INTRODUCTION

Hoppea was established by Willdenow [1, 2] to commemorate Dr. David Heinrich Hoppe, a German botanist and Professor of Natural History at St. Paul's Lyceum. The genus is palaeotropical, distributed mainly in India, Sri Lanka and Pakistan [3, 4] and is represented by two species in the world. *Hoppea* is easily distinguished from related genera by its funnel shaped calyx, smaller corolla and obovate ovaries [5]. The genus forms a monophyletic group which is sister to the genera *Canscora* Lam. and *Schinziella* Gilg., characterized by anisomorphic stamens in which one larger stamen is inserted higher up than the three smaller stamens [6].

MATERIALS AND METHODS

Live specimens collected from wild are used for morphological and anatomical studies. Variations are studied with the help of live as well as consulting specimens housed at various Indian herbaria (BLAT, BSI, BSD, CALI, CAL, DD, KFRI, MH, RHT, RRLB, SNC, SKU and TBGT). Identification is done in consultation with the types and protologue. Colour photographs are taken using Leica EZ4HD stereo microscope. Using fine tweezers, epidermal peelings are taken and stomatal characters are recorded. Free hand sections of stem and leaves are taken with fine blades and stained in toluidine blue, mounted in glycerine and observations are made under the microscope. Using Leica DFC 290 Camera attached to Leica DM 1000 Trinocular Microscope, the sections are photographed.

RESULTS AND DISCUSSION

Systematic treatment

HOPPEA Willd.

Neue Schriften Ges. Naturf. Freunde Berlin 3: 435. 1801; Vahl, Enum. 1: 3. 1805; C.B. Clarke in Hook.f., Fl. Brit. India 4. 100. 1885; Thiv, Blumea 48(1): 29. 2003. **Type:** *Hoppea dichotoma* Willd.

Pladera Sol. ex Roxb. Fl. Ind. 1: 416. 1820. **Type:** *Pladera sessiliflora* Roxb.

Small, erect, glabrous, annual herbs. Stems 4-angular, winged. Leaves simple, opposite, decussate, sessile; lamina green, ovate-rhomboid or oblong-subcordate, 3-nerved at base. Cymes axillary or terminal, 2-3 chotomous. Bracts ovate-lanceolate, green, free. Flowers zygomorphic, tetramerous, sessile or pedicellate, bracteate, ebracteolate. Calyx 4-lobed, funnel shaped, persistent. Corolla 4-lobed, white-cream or yellow. Stamens 4, anisomorphic, one larger, fertile is inserted higher up than the 3 smaller, sterile. Anthers elliptic, yellow-white, longitudinally dehiscent; filaments attached to the corolla exactly close to the sinuses or little below the lobes. Ovary one celled, obovate, bivalved; style very short, green; stigma bilobed, recurved. Fruit a septicidally dehiscent capsule, globose or ellipsoid with persistent calyx. Seeds numerous, elliptic; testa black, reticulate.

Distribution: Two species in the world, distributed in India, Africa, Ethiopia, Philippines, Sri Lanka and Pakistan.

Habitat and ecology: Moist places, wet rocks, ghats, grass lands and open lands.

Key to the species:

1. Flowers sessile or pedicellate; calyx longer than the corolla lobes; corolla yellow; stamens inserted below the sinuses..... **1. *H. dichotoma***
1. Flowers always sessile; calyx shorter than the corolla lobes; corolla cream or white; stamens inserted close to the sinuses..... **2. *H. fastigiata***

1. *Hoppea dichotoma* Willd., Neue Schriften Ges. Naturf. Freunde Berlin 3: 435. 1801; Vahl, Enum. 1:3. 1805; C.B. Clarke in Hook.f. Fl. Brit. India 4. 100. 1885; Gamble, Fl. Pres. Madras 2: 877. 1923; Ramamoorthy in Nicolson & C.J. Saldanha, Fl. Hassan Dist. 426. 1976; Pull. & Moulali, Fl. Andhra Pradesh 2: 605. 1997; Thiv, Blumea 48 (1): 11. 2003.

Type: India, 1800, *Klein s.n.* (holo, B-W image!).

Canscora pusilla Roem. & Schult., Syst. Veg. 3: 301. 1818, 302. 1827; Wall. Cat. 4365; D. Don, Trans. Linn. Soc. London 17: 530. 1837. *Pladera pusilla* Roxb., Fl. Ind. 1: 403. 1832; Griseb. in DC., Prodr. 9: 63. 1845; C.B. Clarke, J. Linn. Soc. Bot. 14: 429. 1875.

Type: Wallich Cat. No. 4366 (CALI!)

Cicendia roxburghii Griseb., Gen. Sp. Gent. 160. 1838.

Erect, glabrous, annual herbs, 1–12 cm high. Stems dichotomously branched, often from near the base, 4-angled, winged; wings not prominent, up to 0.2–0.5 mm wide. Leaves opposite, sessile, 3–6 × 1–4 mm, oblong-subcordate, thick, 3-nerved, apex acute, base cuneate. Cymes axillary or terminal, 2–3 chotomous, dense. Flowers yellow, 4-merous, irregular, sessile or shortly pedicelled; pedicels 2–8 mm long. Bracts green, 2–4.5 × 1–1.5 mm. Calyx tubular or funnel shaped, 2–4.5 mm long, 4-lobed; lobes ovate-acute, 1–2.45 × 0.4–0.8 mm. Corolla shorter than the calyx, funnel shaped, 4-lobed; tube 0.5–3 mm long, lobes 0.5–1.5 × 0.4–0.7 mm, ovate or acute at apex. Stamens 4, inserted at the middle of the corolla tube, a little below the sinuses, anisomorphic with 3 smaller, sterile stamens and one larger fertile stamen; anthers yellow-white, elliptic, larger anther 0.15–0.35 × 0.1–0.3 mm; smaller anthers 0.2–0.3 × 0.1–0.2 mm; filaments of the lower stamens 0.1–0.35 mm long; upper stamen filament 0.25–0.45 mm long. Ovary green, obovate-oblong, 1–2 × 0.5–1.5 mm; style short, green, 0.1–0.2 mm long; stigma bilobed, globose, 0.1 × 0.1 mm. Capsule globular, covered by the calyx, one-celled, 2-valved, 2–4 × 1–2 mm. Seeds numerous, elliptic, 0.25–0.35 × 0.1–0.3 mm; testa black, reticulate.

Chromosome number: 2n = 38 [7].

Flowering and fruiting: September-March.

Habitat and ecology: Abandoned fields, open lands and road sides.

Distribution: India, Africa (Senegal) [8], Ethiopia [9] and Philippines.



Figure. 1. *Hoppea dichotoma* Willd. A. Habit; B & C. Single flower; D. Calyx; E. Corolla opened; F. Gynoecium; G. Corolla with exerted stamen; H. Capsule; I. Seeds (from Shahina P.M. & Shanavas Muhammed 4923).

Specimens examined: **India, Andhra Pradesh**, Adilabad district, 07 December 1985, T. Pullaiah & P.V. Prasannakumar 4016; near Potchera water stream, 21 January 1988, D. Ali moulali & G. Obulesu 5070 (SKU). Cuddaph district, Balapalle, 11 March 1918, C.E.C. Fischer 4276 (CAL); Palakonda hills, 16 January 1989, C. Subbarayudu 8291; *Ibid.*, 10 February 1989, *s.coll.* 5551 (SKU). Guntur district, Krishna river bed, 21 February 1988, V. Ramakrishna Nambiar 6755 (SKU). Hyderabad district, Goleonda, January 1905, A. Meebold 635 (CAL). Karim nagar district, Rechapalli, 23 December 1964, G.V. Subba Rao 22264 (MH). Medak district, Rusthempet, 25 April 1989, K.M. Sebastine 8005 (CAL, MH). Prakasam district, *s.loc.*, 05 December 1983, R.K. Mohan 0348 (CAL). Vishakapatanam district, Arakku valley, 04 December 2011, Shahina P.M. & Shanavas Muhammed 4923 (DEV). **Bihar**, Banka district, *s.loc.*, 11 November 1963, D.M. Verma 1784 (CAL). **Chhattisgarh**, Bastar district, Keskal, 16 November 1958, K. Subramaniam 7111 (CAL). Bilaspur district, Menderi, 01 November 1970, G. Panigrahi 13251 (CAL). **Gujarat**, Rajkot district, Saurashtra, 07 November 1953, M.B. Raizada 2367 (DD). **Himachal Pradesh**, Hamirpur district, 26 March 1962, U.C. Bhattacharrya 20428 (BSD). **Jharkhand**, Dhanbad district, Chota Nagpur, 03 November 1883, C.B. Clarke 34054; *Ibid.*, 08 November 1873, C.B. Clarke 20794; *Ibid.*, January 1903, D. Prain 10; *Ibid.*, 24 December 1993, S. Chandar 20925 (CAL). Goelkera district, Goelkera, 27 December 1960, G.V. Subba Rao 22703 (CAL). Hazaribagh district, Parasnath wildlife sanctuary, 19 November 2003, Vinay Ranjan & K.I. Maity 33620 (CAL). Jamtara district, Mihijam, 31 October 1900, N.Gill *s.n.* (CAL). **Karnataka**, Bellary district, Chincholi R.F., 20 January 1976, N.P. Singh 42695; *Ibid.*, 21 January 1976, N.P. Singh 142733 (BSI). Bidar district, Bidar road, 21 January 1976, N.P. Singh 142734 (BSI). Chitradurga district, Chitradurg, 11 January 1976, N.P. Singh 142318 (BSI).

Dharwad district, Dharwad, March 1919, *L.J. Sedgwick & T.R.D. Bell 5501* (CAL). Gulbarga district, Chinchole Road, 09 February 1975, *N.P. Singh 128615* (BSI). Kolar district, Royal pad, 04 January 1976, *N.P. Singh 142062* (BSI). Mandya district, Sivasamudram 04 March 1978, *Syed Maqsood Ahmad 336* (CAL). Raichur district, Kurdi, 19 December 1962, *A.S. Rao 83891* (BSI). South Canara district, Sitanadi, 08 November 1960, *R.K. Arora 3416*; *Ibid.*, 18 November 1962, *R.K. Arora 2695* (CAL). Uduppi district, Mookambika wildlife sanctuary, Hadangundi forest area 14 October 08, *P.G. Diwakar & R.Kr. Singh 184448* (BSI). **Madhya Pradesh**, Betul district, Khandara, 06 December 1988, *J.S. Gamble 8350* (DD). Bilaspur district, Korba to Kudmina, 21 February 1972, *G. Panigrahi 16798* (CAL). Gwalior district, Gwalior, December 1889, *C. Maries Begh 223* (CAL). Indore district, Patalpani, 20 April 1963, *A.R.K. Shastry 87509* (BSI). Jhabua district, Bhimkund, 12 December 1988, *J.F. Duthie 8350* (CAL). Khargone district, Balwada Tank, 16 December 1961, *A.S. Rao 79128* (BSI). Mandla district, Kanha national park, November 1970, *R.M. Singhal s.n.* (DD). Rajpur district, Rajpur, 01 October 1961, *Hari Om Saxena 2289* (DD). Rewa district, 26 February 1987, *R. Prasad 38487* (CAL). Satna district, Satna, 19 September 1959, *K.M. Sebastine 8872* (CAL). Saugor district, Rahtgarh, 01 March 1960, *K. Subramaniam 10127* (CAL). Sidhi district, Majhanli, 16 January 1964, *G. Panigrahi 2118* (CAL). **Maharashtra**, Akola district, Adaridam, 27 November 1979, *S.Y. Kamble 160875*; Kinhiraja road, Mangaralpir, 30 September 1977, *S.Y. Kamble 150266*; Morna dam, 22 February 1978, *S.Y. Kamble 152773* (BSI). Amravati district, Amravati university campus, 29 October 2012, *Alfredjoe & Pramod 4340* (DEV); Dhulghati area, 14 November 1979, *M.Y. Ansari 160628* (BSI). Chandrapur district, Chandrapur district, Chandrapur, 01 January 1990, *J.F. Duthie 9572* (CAL, DD); Jaminu road, 28 February 1971, *B.M. Wadhwa 133591* (BSI). Dhulia district, Dhulia, 29 December 1909, *R.K. Bhide s.n.*; on the way to Aspa, 05 March 1965, *R.D. Pataskar 104109* (BSI). Jalgaon district, Pimpalgaon forest, 22 December 1983, *K.M. Rao 166915* (BSI). Nagpur-amravati road, 17 September 1963 *R.S. Rao 91688* (BSI). Nagpur district, 13 November 1957, *K. Subramaniam 4553* (CAL). Mumbai district, on way to Aspa, 05 March 1965, *R.D. Pataskar 104109* (CAL). Nanded district, Yeshwantnagar stream, 24 April 1963, *A.R.K. Sastry 87603* (BSI). Nasik district, Khandala 02 February 1906, *W.A. Talbot 4792*; Nasik, 02 February 1906, *A.R.K. Sastry 4792* (BSI). Pune district, Talegaon, 25 December 1962, *R.S. Rao 85276* (BSI); Karegaon, near Penganga river, 25 September 1978, *S. Karthikeyan 156627* (BSI). Thane district, Kharegaon, 08 February 1987, *M. Prasad 39403* (CAL); Mumbra hill, 09 September 1968, *K.V. Billore 116499* (CAL, BSI); Vithalwadi, 09 March 1956. *S.D. Mahajan 10443* (BSI). **Meghalaya**, East Khasi hills district, Khasi hills, *s.coll. s.n.* (CAL). **Odisha**, Ganjam district, Ganjam, December 1889, *J.S. Gamble 21701* (BSI); *Ibid.*, 23 January 1890, *C.A. Barber 1216* (MH); *Ibid.*, 28 October 1975, *Hari Om Saxena 1998*; Panigraha, 31 October 1973, *Hari Om Saxena 1144* (RRLB). Mayurbhanj district, Similipahar, 30 September 1981, *Hari Om Saxena 4849*; *Ibid.*, 26 August 1982, *Hari Om Saxena 4793* (RRLB). Sambalpur district, Garpati forest, 21 October 1947, *H.F. Mooney 2913*; *s.loc.*, 12.1880, *J.S. Gamble 8706* (DD). Sundargarh district, Hetamnadi, 30 January 1961, *G. Panigrahi 23579*; Liang, 18 March 1988, *R. Mukherjee & D. Namhala 3447*; Panposh, 04 March 1966, *R.K. Arora 4512* (CAL). **Panjab**, Hoshiarpur district, Sohan nadi, 21 March 1902, *s.coll. 15563* (CAL); Talwara, 02 September 1977, *J.N. Vohra & P. Daniel 60456*; Onchoe beds, 12 November 1959, *T.A. Rao 10795* (BSD). **Rajasthan**, Banswara district, Khora forest, 18 October 1976, *V. Singh 3725* (CAL). Bhilwara district, Bhilwara, 01 October 1978, *A.N. Singh 5704* (CAL); Jamoli, 28 September 1995, *Surendra Singh 90207* (BSD). Jhalawar district, Kyasra, 17 December 1963, *D.M. Verma 1784*; *Ibid.*, 16 December 1964, *D.M. Verma 6807* (CAL). Sambalpur district, Penoin, 04 November 1986, *Saurish Panda 296*; *Ibid.*, 06 November 1986, *Saurish Panda 342* (CAL). **Tamil Nadu**, Chennai district, Chennai, January 1884, *J.S. Gamble 13755* (MH). Chingleput district, Kelambakkam, *A.N. Henry 47141* (CAL, MH); *Ibid.*, 12 September 1911, *s.coll. 10244*; Kambakam hills, March 1914, *s.coll. 10245*; Ramanpatham-muniam road, 06 March 1989, *S. Ragupathy 1003* (MH). Coimbatore district, Maruthamalai, 15 March 1986, *C. Avulappan 736* (MH). Dharmapuri district, Dharmapuri, 12 February 1980, *K.M. Matthew 26464*; *Ibid.*, 29 October 1981, *S.J. Britto & N. Ravi 28507* (RHT). Nagapattinam district, Caleroon river, 11 January 1977, *Arockiasamy 6135*; Kollidam, 18 November 1974, *K.M. Matthew 14722*; Thuraiyur, 16 March 1978, *K.M. Matthew 12275*; *Ibid.*, on the bank of river, 26 February 1976, *C. Rajamani 1277* (RHT). Nilgiris district, Ooty, 10 October 1958, *C.M. Arora 1179* (MH). Pudukkottai district, Pudukkottai, 24 March 1884, *K.M. Matthew 29955* (RHT). Salem district, Chinnakarrayans, Vilakkapattu village, 21 February 1979, *T.S. Jayseelan 21966*; Hosur, 29 December 1916, *s.coll. 13938*; Manmalai village lands, 24 February 1980, *K.M. Matthew 26062* (RHT); Salem, 29 December 1916, *s.coll. s.n. 13938* (MH). South Arcot district, near forest rest house, 30 January 1979, *N. Venugopal 21464* (RHT).

Thanjavur district, Ammasatharam, 30 January 1969, *K.M. Matthew* 9873 (RHT); Ramanathapuram, 06 March 1989, *S. Regupathy* 1003 (CAL, MH). Tiruchirappally district, Kondayampettai, 06 February 1969, *K.M. Matthew* 9957 (RHT); Sengattupatty, 16 March 1976, *K.M. Matthew* 1275 (MH); Srirangam island, 07 March 1992, *C.D.K. Cook* 30759 (RHT); Thuraiyur, 16 March 1978, *K.M. Matthew* 12275; *s.loc.*, 28 December 1990, *J.J. Wood* 235 (MH). Tiruvallur district, Red hills, 20 March 1830, *E. Barnes s.n.* (DD). **Tripura**, Dhalai district, Krani plateau, 04 October 1909, *I.H. Burkill* 33295 (CAL). West Tripura district, Kunjaban, 17 December 1957, *G. Panigrahi* 11875 (CAL). **Uttarakhand**, Dehradun district, Bawar, 09 December 1986, *J.S. Gamble* 6608 (DD); Dehradun, October 1989, *J.F. Duthie* 9033 (DD); *Ibid.*, August 1894, *J.S. Gamble* 24983 (CAL); *Ibid.*, Mussorie, 07 October 1960, *Hari Om Saxena* 1382; *Ibid.*, August 1894, *J.S. Gamble* 24983; *Ibid.*, August 1939, *M.B. Raizada s.n.* (DD); Rispana, 13 September 1964, *C.R. Babu* 34725; Gularghati, 02 December 1960, *C.L. Malhotra* 12490 (BSD). Nainital district, Corbet National Park, 07 December 1972, *K.P. Janarthanam* 51359 (BSD). **Uttar Pradesh**, Agra district, Goimah, *s. die*, *King* 2632 (CAL). Chitrakoot district, Chitrakoot, 17 November 1957, *M.A. Rau* 3810 (BSD). Gorakhpur district, Gorakhpur, 24 October 1962, *J.K. Maheswari* 4133 (CAL). Jhansi district, Bundelkhand, 30 December 1987, *J.S. Gamble* 7004 (DD). Meerut district, Mohand, October 1924, *J.S. Murty & A.K. Goel* 1112 (BSD). Mirzapur district, Hatala, 14 October 1969, *G. Panigrahi* 12533 (CAL); T. Falls, 08 February 1961, *U.C. Bhattacharya* 12899; Tanda, 07 December 1961, *U.C. Bhattacharya* 18383 (BSD). **West Bengal**, Bankura district, Bishmapur, 14 January 1965, *M.N. Sanyal* 482; Katiam hill, 26 December 1958, *J.C. Sengupta* 2071 (CAL). Birbhum district, Ballabhpur wildlife sanctuary, 07 March 2008, *A.K. Sinha* 48320; Birbhum, 13 October 1968, *R.K. Basak* 931 (CAL). Medinipur district, Gopi ballphpur range, Mekragudi, 30 November 1976, *S.K. Majhi* 2932; Medinipur, 25 February 1965, *T.A. Rao* 4049 (CAL). Purulia district, Purulia, 28 December 1990, *J.J. Wood* 235 (MH). **Notes:** *Hoppea dichotoma* is characterized by its sessile-pedicellate flowers, calyx always exceeding the corolla and the stamens inserted on the corolla below the sinuses. Willdenow [1], though described the flowers as “parvi alba”, our specimens all have yellow corolla. Gamble [12] also described the flowers as pale yellow.

2. *Hoppea fastigiata* (Griseb.) C.B. Clarke in Hook.f., Fl. Brit. India 4: 100. 1885; Merr., Enum. Philipp. Fl. Pl. 3: 318. 1923; Gamble, Fl. Pres. Madras 2: 877. 1923; Ramamoorthy in Nicolson & C.J. Saldanha, Fl. Hassan Dist. 426. 1976; V.S. Ramach. & V.J. Nair, Fl. Cannanore 292. 1988; Vajr., Fl. Palghat 300. 1990; M. Mohanan & A.N. Henry, Fl. Thiruvannathapuram 308. 1994; Sasidh. & Sivar., Fl. Thrissur 299. 1996; N. Mohanan, Fl. Agasthyamala 464. 2002; Thiv, Blumea 48(1): 29. 2003; Anilkumar *et al.*, Fl. Pathanamthita 328. 2005.

Exacum fastigiatum Arn. ex Griseb., Gen. Sp. Gent. 158. 1838.

Pladera pusilla Thwaites, Pl. Zeyl. 204. 1860.

Pladera fastigiata C.B. Clarke, Linn. Soc. Bot. 14: 429. 1875.

Exacum concinnum Miq. ex C.B. Clarke in Hook.f., Fl. Brit. India 4: 100. 1883.

Type: Ceylon, Colombo, *s. die*, *Macrae s.n.* (lecto, K).

Erect, glabrous, annual herbs, 1–20 cm high. Stems green, simple-dichotomously branched, 4-angled and 4-winged; wings 1 mm wide. Leaves thick, apex obtuse, base truncate, 2.5–10 × 1.5–8 mm, opposite, sessile, broadly ovate, rhomboid, 3-nerved. Cymes axillary or terminal, 2-3 chotomous, dense. Flowers cream-white, 4-merous, irregular, sessile. Bracts green, linear-lanceolate, 2–4.5 mm long. Calyx 4-lobed, funnel shaped, 2–3.5 mm long; lobes linear-lanceolate, 1–2 × 0.4–0.8 mm, acuminate at apex. Corolla 4-lobed; funnel shaped; tube 0.7–2 mm; lobes cream or white, oblong, longer than the calyx, 1–1.5 × 0.45–0.8 mm. Stamens 4, inserted close to the sinuses, anisomorphic with 3 smaller sterile stamens and one larger fertile stamen; anthers yellow-white, elliptic, larger anther 0.15–0.25 × 0.1–0.3 mm; smaller anthers 0.15–0.25 × 0.3–0.25 mm; larger stamen filament 0.25–0.4 mm long, smaller stamen filament 0.05–0.2 mm long. Ovary green, oblong-elliptic, 1–3.5 × 0.5–1.5 mm, 1-celled, ovules many; style green, 0.5–1 mm long; stigma 2-lobed, white, 0.1–0.3 × 0.1–0.2 mm; subglobose. Capsule ellipsoid with persistent calyx, 2–4 × 1–1.5 mm. Seeds numerous, minute, subglobose, 0.3–0.4 × 0.15–0.25 mm; testa black, wrinkled.

Chromosome number: **2n = 38** [9].

Flowering and fruiting: July-March.

Habitat and ecology: Very common on wet rocks, grass lands, fields and lateritic soils.

Distribution: India and Sri Lanka.

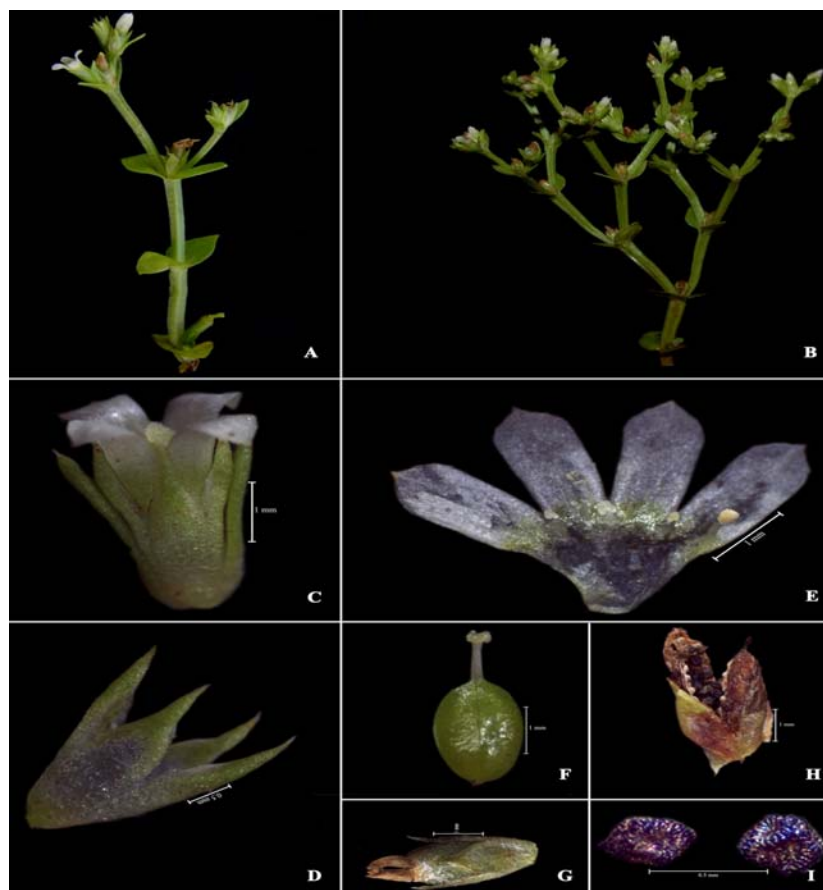


Figure 2. *Hoppea fastigiata* (Griseb.) C.B. Clarke: A & B. Habit; C. Single flower; D. Calyx; E. Corolla opened; F. Gynoecium; G. Fruit; H. Fruit dehisced; I. Seeds (A from Shahina P.M. & Alfredjoe 4903; B - I. from Shahina P.M. & Anna Ancy Antony A. 4926).

Specimens examined: **India, Andhra Pradesh**, Vishakapatnam district, Yellapore, *s.die*, W.A. Talbot 649 (BSI). **Goa**, North Goa district, Bicholin-ponda, 12 September 1963, *John Cherian 106119* (BSI, CAL); Bowanbunda, 19 September 1970, *N.P. Singh 124391*; Cavanzal, 13 September 1970, *N.P. Singh 124838*; Goa, 18 September 1970, *N.P. Singh 124352*; Potty forests, 28 August 1963, K.C. Kanodia 89609 (BSI). **Karnataka**, Bangalore district, Savandurga, 23 September 1978, *S.B. Manohar & K.R. Kesava Murthy 2832* (CAL). Belgaum district, Molem Belgaun road, 18 September 1990, *N.P. Singh 124352*; *Ibid.*, 19 September 1970, *N.P. Singh 124391* (CAL). North Canara district, *s.loc.*, 1918, *W.A. Talbot 649* (CAL). Shimoga district, Jog falls, 09 November 1987, *Sujaya T. 10903* (MH). South Canara district, South Canara, 25 October 1900, C.A. Barber 2061 (MH); Sullia, 25 October 1900, *s.coll. s.n.* (CAL). **Kerala**, Alappuzha district, 11.1909, *A. Meebold 12524* (CAL). Idukki district, Wagamon, 07 December 2010, *Shahina P.M. & Shweta S. 4126* (DEV). Kannur district, Kannothe R.F., 07 November 1978, V.S. Ramarchandran 58293 (CAL, MH); Madaipara, 28 September 2010, *Shahina P.M. & Santhosh Nampy 3491* (DEV). Kollam district, Asram, 11 October 1986, *Anirudhan K. 172*; Kollam, 07 January 1986, *Reetha V. 526* (SNC); Perumalai, Konni R.F., 18 November 1976, *M. Chandrabose 49105* (CAL, MH). Kozhikode district, Chelannur, 23 September 2010, *Shahina P.M. & Jhony 3435*; *Ibid.*, 24 September 2012, *Shahina P.M., Anna Ancy Antony A. & Santhosh Nampy 4926* (DEV). Malappuram district, Calicut university, 06 October 1985, *Babu A. 38371* (CAL, CALI); Malappuram district, Nedumkayam, 14 November 1915, *s.coll. 3836* (MH); Nilambur, Karimpuzha, 12 December 1980, *s.coll. 32323* (CALI); Nedumkayam, 14 November 1915, *C.E.C. Fischer 3836* (CAL). Pathanamthitta district, Neriambangalam, 01 October 1988, *Anilkumar 2503* (SNC). Palakkad district, Dhoni hills, 23 October 1963, *s.coll. 17858* (MH); Pulayinpara, 15 September 2011, *Shahina P.M. & Beevikutty T.M. 4945* (DEV); Silent valley, Aruvanpara, *s.die*, *Prasannakumar K. 11010* (CALI); *Ibid.*, 08 December 1980, *N.C. Nair & P. Bhargavan 691714* (CAL); *s.loc.*, 08 December 1980, *N.C. Nair 69171* (MH).

Thiruvananthapuram district, Agasthyamala, 19 January 1988, *N. Mohanan* 7955; Attayar, 17 December 1990, *N. Mohanan* 7664 (TBGT); Bonaccord estate, 09 October 1973, *J. Joseph* 44650 (MH). Thrissur, district, Chalakkudi, Athirapally, 27 September 1982, *K. Ramamurthy* 74886 (MH); Kalluchal, Peechi, 22 September 1987, *N. Sasidharan* 4633 (KFRI); Mulloorkara, 21 August 2010, *Shahina P.M. & Santhosh Nampy* 3060; Onnamkallu, 14 November 2010, *Shahina P.M. & Asif* 3968; Paruvanmala, 03 October 2011, *Shahina P.M. & Alfredjoe* 4903; *Ibid.*, 26 August 2012, *Shahina P.M. & Sandhya* 4924; *Ibid.*, 12 November 2011, *Shahina P.M. & Shanavas Muhammed* 4980 (DEV); Pattikkad, 03 October 1988, *N. Sasidharan* 5144 (KFRI); Vellani mala, 03 October 1988, *N. Sasidharan* 5144 (CALI). **Maharashtra**, Satara district, Mahabaleshwar, 04 November 1987, *Ajitha P.S.* 13477; *s.loc.*, 05 December 1987, *Prasitha A.K.* 12977 (CALI). **Odisha**, Koenjhar district, *s.loc.*, 03 October 1946, *H.F. Mooney* 2789 (DD). **Tamil Nadu**, Dharmapuri district, Dharmapuri, 14 November 1979, *K.M. Matthew* 24583 (RHT). Nilgiris district, Gudalur, January 1884, *J.S. Gamble* 13755 (CAL). Pudukkottai district, Narthamalai, 15 March 1986, *C. Avulappan* 736; *s.loc.*, December 1883, *J.S. Gamble* 13609 (MH). Salem district, Yercaud, 07 December 1985, *Sobha V.S.* 410 (SNC). Tirunelvely district, Courtallum, 16 December 1957, *K. Subramanyam* 4937 (MH). **West Bengal**, Bhirbum district, Ballapur wildlife sanctuary, 27 October 2008, *A.K. Sinha* 44806 (CAL).

Notes: *Hoppea fastigiata* is easily distinguished by always sessile flowers, cream-white corolla, which is always longer than the calyx and the stamens attached close to the sinuses of corolla. The stem is either simple or profusely dichotomously branched.

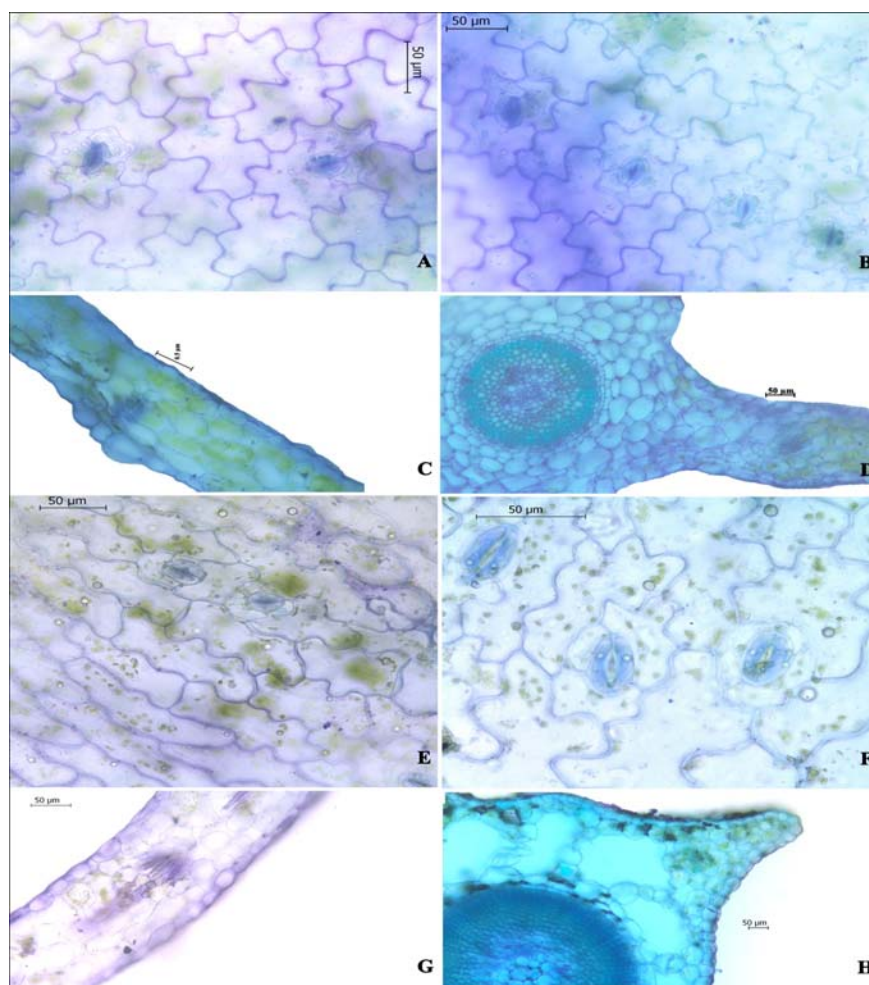


Figure 3. A - D. *Hoppea dichotoma* Willd. A & B. Stomata on the adaxial and abaxial epidermis; C. L.S. of leaf; D. T.S. of stem. E - H. *Hoppea fastigiata* (Griseb.) C.B. Clarke E & F. Stomata on the abaxial and adaxial epidermis; G. L.S. of leaf; H. T.S. of stem.

ANATOMICAL FEATURES

The anatomy of *Hoppea dichotoma* and *H. fastigiata* are distinct.

Leaf anatomy shows single layered epidermis and chlorenchymatous hypodermis. The mesophyll cells include palisade and spongy parenchyma. Vascular bundles are conjoint, collateral and open. Minor leaf veins are present. The stomatal characters of the two species are more or less similar having anisocytic stomata with 3 subsidiary cells, distributed more on the abaxial surface than the adaxial surface. Subsidiary cells are wavy and the degree of waviness differs in each species. *H. dichotoma* have strict undulations and that of *H. fastigiata* shows loose undulations. Transverse section of the stem of *Hoppea dichotoma* shows amphiphloic siphonostele with an inversely oriented cortical bundles at the angles of the stem where as *H. fastigiata* also shows included phloem, characteristic feature of the family Gentianaceae without the presence of cortical bundles. The presence of cortical bundles in the stem of the Gentians has been known only in certain species of the subfamily Menyanthoideae [10]. Kshetrapal [11] in the vascular anatomy of the node and flower of *Hoppea dichotoma* discussed the presence of discrete inversely oriented cortical bundles in the region of four angles of the stem. In our studies, we could also locate the presence of cortical bundles in the four arms of the section.

CONCLUSION

The genus *Hoppea* Willd. comes under the exclusively palaeotropical subtribe Canscorinae of the tribe Chironieae which is sister group to Gentianaceae, Helieae and Potalieae. Intergeneric relationships were discussed by Thiv and Kadereit [5]. They included the genus *Hoppea* in a single clade along with *Canscora*, *Cracosna* and *Schinziella* based on morphological and molecular analysis. Anisomorphic androecium is a well supported character while including the genus in the tribe Canscorinae. The major anatomic features such as anisocytic stomata and three undulated subsidiary cells are constant in both species of *Hoppea*. Even if the degree of undulations differs in both species and the presence of cortical bundles restricted to one species (*H. dichotoma*), we cannot consider the anatomical characters alone while separating the two species.

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