CHAPTER 4

RESULTS

4.1. Enlistment of the genus *Glochidion* in Assam

The present work is a consequence of an in-depth study of the genus *Glochidion* J.R. Forst. & G.Forst. in Assam. As a result, a total of 10 taxa were documented from diverse parts of the study area. The collected taxa are enlisted in **Table 1** along with their collection localities, GPS coordinates, and accession numbers.

Table 1. List of the taxa with their collection sites, GPS coordinates, and accession numbers

Sl. No.	Taxa	Locality	Accession No.	GPS coordinates
1	*Glochidion ellipticum* Wight	Sutarpara, Kokrajhar District, Assam	98605	N 26˚29.041′ E 090˚20.355′
2	*G. heyneanum* (Wight & Arn.) Wight	Siljan, Kokrajhar District, Assam	98606	N 26º22.925' E 090º20.262'
3	*G. lanceolarium* (Roxb.) Voigt	Bedlangmari, Kokrajhar District, Assam	98608	N 26º19.385' E 090º15.887'
4	*G. multiloculare* (Rottler ex Willd.) Voigt var. *multiloculare*	Debargaon, Kokrajhar District, Assam	98604	N 26º29.902' E 090º20.351'
5	*G. multiloculare* var. *pubescens* Chakrab. & M.Gangop.	Orang National Park, Udalguri District, Assam	98610	N 26º32.909' E 092º17.170'
6	*G. sphaerogynum* (Mull.Arg.) Kurz	Salbari, Chakrashila Wildlife Sanctuary, Kokrajhar District, Assam	98609	N 26º17.025' E 090º21.089'

7	*G. zeylanicum* var. *arborescens* (Blume) Chakrab. & M.Gangop.	Ultapani Forest Range, Kokrajhar District, Assam	98603	N 26º46.1212' E 090º17.228'
8	**G. zeylanicum* var. *paucicarpum* Chakrab. & N.P. Balakr.	Owabari, Daolur dwisa, Kokrajhar District, Assam	099973	N 26º37.131' E 090º18.784'
9	*G. zeylanicum* var. *tomentosum* Trimen	Ultapani Forest Range, Kokrajhar District, Assam	98607	N 26º46.020' E 090º17.477'
10	*G. zeylanicum* (Gaertn.) A.Juss. var. *zeylanicum*	Nokpakghat, Karbi Anglong District, Assam	98611	N 26º16.422' E 093º03.562'

4.2. Taxonomic enumeration

Glochidion J.R. Forst. & G.Forst., Char. Gen. Pl. 113, t. 57. 1776; A.Juss., Tent. Euphorb. 107, t. 3. 1824 & ibid., No. 27: 18. 1824; Blume, Bijdr. Fl. Ned. Ind. 585. 1826; Baillon, Etude Gen. Euph. 638. 1858; Mull.Arg. in Linnaea 32: 57. 1863; Kurz, Forest Fl. Brit. Burma 2: 341. 1877; Hook.f., Fl. Brit. India 5: 305. 1890; Pax & K.Hoffm. in Engler, Pflanzenfam. Ed. 2, 19c: 56. 1931; Kanjilal et al., Fl. Assam 4: 179. 1940; Airy Shaw in Kew Bull. 26: 271. 1972; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 176. 1995; N.P. Balakr. & T.Chakrab., Fam. Euph. India 342. 2007; Borthakur et al., Fl. BTAD 3: 74. 2018; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 194. 2018.

Monoecious and rarely dioecious; primarily of shrubs or trees; pubescent or glabrous; droopingly branched. Leaves simple, alternate, usually asymmetrical at the base, entire, petiolate, stipulate. Inflorescence usually axillary, supra-axillary, or pedunculate, with few to many flowers. Male flowers mostly long pedicellate, with sepals 3–6, free; petals and disc absent; stamens 3–8, sessile; anthers linear, 3–12, connective; pistillode absent. Female flowers shortly pedicellate or sessile; sepals 3–6, free to connate; petals and disc absent; staminodes absent; ovary 3–14 locular, biovulate locules; styles usually connate into a column, conical, globose. Fruits capsular, pedicellate or sessile with a style column

at the apex, depressed, subglobose, unlobed, and deeply or conspicuously lobed, pubescent or glabrous, green, white, or creamy to reddish; seeds usually 3–14, compressed, hemispherical with an arillate coat; cotyledons flat.

4.2.1. Key to the species

1a. Inflorescence axillary……**2**

1b. Inflorescence supra-axillary, pedunculate, rarely axillary……**6. *G. zeylanicum***

2a. Fruiting pedicellate, short…….**3**

2b. Fruiting non-pedicellate or sessile……....**3. *G. lanceolarium***

3a. Capsule green to white creamy, superficially lobed……**1. *G. ellipticum***

3b. Capsule green to yellowish green, conspicuously lobed…….**4**

4a. Style distinct, forming in a ring……....**4. *G. multiloculare***

4b. Style columnar, subglobose, discoid……..**5**

5a. Anthers 3–4, 0.1–0.12 cm long……..**2. *G. heyneanum***

5b. Anthers 3–5, 0.1–0.15 cm long ……..**5. *G. sphaerogynum***

1. *Glochidion ellipticum* Wight, Icon. Pl. Ind. Orient. 5(2): 29, t. 1906. 1852; Hook.f., Fl. Brit. India 5: 321. 1890; T.Cooke, Fl. Bombay 2: 579. 1908; Gamble, Fl. Madras 2: 915. 1957; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 199–203. 1995; S.S. Preetha, Fl. Kerala 169–170. 2007; N.P. Balakr. & T.Chakrab., Fam. Euph. India 348. 2007; Borthakur et al., Fl. BTAD 3: 74–75. 2018; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 212–216. 2018.

— ***Phyllanthus assamicus*** Mull.Arg. in Flora 48: 378. 1865 & in DC., Prodr. 15(2): 297. 1866.

— ***Glochidion assamicum*** (Mull.Arg.) Hook.f., Fl. Brit. India 5: 319. 1887; Prain, Bengal Pl. 2: 931. 1903; Haines, bot. Bihar Orissa 2: 131. 1921; Kanjilal et al., Fl. Assam 4: 187. 1940; Airy Shaw in Kew Bull. 26: 274. 1972; D.B. Deb, Fl. Tripura 1: 335. 1981; M.Short & A.R. Vickery in H. Hara et al., Enum. Fl. Pl. Nepal 3: 196. 1982: D.G. Long in Grierson & D.G. Long, Fl. Bhutan 1(3): 779. 1987; Bora & Kumar, Fl. Div. Assam 304. 2005; R. Daimary, Fl. Div. Kokrajhar Dist. Assam 418. 2011.

— ***Phyllanthus malabaricus*** Mull.Arg. in Linnaea 34: 69. 1865 & in Flora 48: 386. 1865 & in DC., Prodr. 15(2): 305. 1866.

— ***Glochidion malabaricum*** (Mull.Arg.) Bedd., Fl. Sylv. S. India Forester's Man. 194. 1873; Hook.f., Fl. Brit. India 5: 319. 1887; T.Cooke, Fl. Bombay 2(3): 578. 1906; Gamble, Fl. Madras 2(7): 1308. 1925; C.J. Saldanha, Fl. Karnataka 2: 145. 1996; A.N. Londhe in N.P. Singh et al., Fl. Maharashtra, Dicotyledons 2: 889. 2001.

— ***Phyllanthus diversifolius*** Miq. var. ***wightianus*** Mull.Arg. in Flora 48: 378. 1865 & in DC., Prodr. 15(2): 298. 1866.

— ***Glochidion diversifolium*** (Miq.) Bedd. var. ***wightianum*** (Mull.Arg.) Bedd., Fl. Sylv. S. India Forester's Man. 193. 1872.

— ***Glochidion ellipticum*** var. ***wightianum*** (Mull.Arg.) Hook.f., Fl. Brit. India 5: 321. 1887.

— ***Phyllanthus diversifolius*** Miq. var. ***longifolius*** Mull.Arg, in Flora 48: 378. 1865 & in DC., Prodr. 15(2): 298. 1866.

— ***Phyllanthus andersonii*** Mull.Arg. in Flora 55: 3. 1872.

— ***Glochidion ralphii*** Hook.f., Fl. Brit. India 5: 314. 1887.

— ***Glochidion ellipticum*** Wight var. ***ralphii*** (Hook.f.) Gamble, Fl. Madras 2(7): 1308. 1925.

— ***Glochidion balakrishnanii*** Jothi et al. in J. Econ. Taxon. Bot. 26: 114, f. 1. 2002.

***Vernacular names*:** Panimadhuri (Assamese), Thakha biphang or thakha mala (Bodo), Latimaowa (Nepali)

Monoecious; shrubs or trees, drooping branched, branchlets brown or blackish, glabrous; bark brown outside, creamy inside. Leaves alternate, simple, glabrous, oblong, elliptic, lanceolate, obovate, 4–25 × 2–8 cm, acuminate at apex, acute, attenuate, obtuse or rounded at base, thinly coriaceous, glossy green, creamy, brown when dry, petiolate, stipulate, margin entire, veins reticulate, lateral nerves 5–10 per side; petioles 0.9–1 cm long, glabrous, green; stipules triangular, 0.1–0.11 cm long, glabrous, light green at young, brown at mature and dry. Inflorescence axillary, dense flowered. Male flowers long pedicellate, 1.5–1.7 cm long, glabrous, light yellow; sepals 6, linear, oblong, 0.1–0.2 cm long; anthers 4–5, 0.1–0.13 cm long, light yellow, brown. Female flowers short pedicellate, 0.4–0.5 cm long, glabrous, greenish; sepals 6, elliptic, oblong, 0.1–0.2 cm long; ovary subglobose, 3–6 locular, 0.1–0.12 cm long, sparsely pubescent, creamy white, green; style conical, columnar, 0.1–0.2 cm long, light green, creamy. Capsules depressed, subglobose,

pedicellate, shallowly lobed to unlobed, biovulate, 3–6 locular, 1–1.1 cm long, numerous in the axil, sparsely pubescent at mature, light green at young, creamy white at mature, dark brown when dry; seeds brown or red at mature. **(Plate 1, Figure 2)**

Fruiting & Flowering: Jan. – Dec.

Habitat: Evergreen and deciduous forests, primary and secondary forest areas, roadside areas.

Distribution: India, Bangladesh, Bhutan, China, Myanmar, Nepal, Taiwan, Thailand, Vietnam.

***Specimen Examined*: INDIA. ASSAM:** Kokrajhar District, Sutarpara, N 26˚29.041′ E 090˚20.355′ 26-08-2020, *P. Brahma* 003 (ASSAM, Accession no. 98605); Ultapani Forest Range, N 26º38.539' E 090º17.397', 07-12-2020, *P. Brahma* 020; Baksa District, Manas National Park, N 26º45.828' E 091º00.213', 11-11-2020, *P. Brahma* 015, Kokrajhar District, Dimalgaon, N 26º25.480' E 090º16.311', 04-03-2021, *P. Brahma* 028; Cachar District, Dholchera, N 24º54.057' E 092º54.497', 22-03-2021, *P. Brahma* 030; Udalguri District, Barnodi Wildlife Sanctuary, N 26º46.852' E 091º45.336', 23-12-2021, *P. Brahma* 032; Nunoi Forest Range, N 26º54.957' E 091º52.766', 24-12-2021, *P. Brahma* 033; Sonitpur District, Balipara Reserve Forest, N 26º56.029' E 092º47.947', 05-01-2023, *P. Brahma* 041; Nameri National Park, N 26º56.672' E 092º51.351', 06-01-2023, *P. Brahma* 046.

***Additional Specimen Examined*: INDIA. ASSAM:** Sibsagar District, 05-03-1915, *U. Kanjilal* 4354 (ASSAM); Jorhat District, near Golaghat forest, 27-03-1962, *J.G. Srivastava & Party* 81256 (LWG); Nowgong District, 20-08-1964, *N.P. Balakrishnan* 39290 (ASSAM); Jorhat District, Gibbon Wildlife Sanctuary, 25-02-2011, *R. Daimary* 121672 (ASSAM); **MEGHALAYA:** Tura, Garo hills, 28-05-1958, *B.K. Nayar & Party* 50845 (LWG); **WEST BENGAL:** Buxa National Park, 13-10-2009, *G. Krishna* 46330 (CAL0000212485: image!); Jaldapara National Park, 23-09-2012, *K. Karthigayan* 58983 (CAL0000212486: image!); **ODISHA:** Raigada, 11-05-2016, *Mahan & Swamy* 7696 (BSID0011139: image!); **MADHYA PRADESH:** Bandhavgarh, 24-03-1967, *S.D.N. Tiwari* 20112; *J.E. Stocks & J.S. Law* 42 (K000246404: image). **BURMA.** 04-1846, *s. coll.* 2576 (K000246406: image!).

2. *Glochidion heyneanum* (Wight & Arn.) Wight, Icon. Pl. Ind. Orient. 5(2): 29, t. 1908. 1852; Hook.f., Fl. Brit. India 5: 323. 1890; Prain, Bengal Pl. 2: 930. 1903; Kanjilal et al., Fl. Assam 4: 186. 1940; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 205–208. 1995; S.S. Preetha, Fl. Kerala 170–171. 2007; N.P. Balakr. & T.Chakrab., Fam. Euph. India 348–349. 2007; R. Daimary, Fl. Div. Kokrajhar Dist. Assam 418–419. 2011; Borthakur et al., Fl. BTAD 3: 75. 2018; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 217–221. 2018.

— ***Phyllanthus heyneanus*** (Wight & Arn.) Mull.Arg. in Flora 48: 389. 1865 & in DC., Prodr. 15(2): 311. 1866.

— ***Glochidion velutinum*** Wight, Icon. Pl. Ind. Orient. 5(2): t. 1907, f. 2. 1852; Bedd., Fl. Sylv. S. India Forester's Man. 195. 1873; Hook.f., Fl. Brit. India 5: 322. 1887; Prain, Bengal Pl. 2: 931. 1903; T.Cooke, Fl. Bombay 2(3): 578. 1906; Duthie, Fl. Gangetic Plain 3(1): 90. 1915; Haines, Bot. Bihar Orissa 2: 131. 1921; Gamble, Fl. Madras 2(7): 1307. 1925; Kanjilal et al., Fl. Assam 4: 185. 1940; M.Short & A.R. Vickery in H. Hara et al., Enum. Fl. Pl. Nepal 3: 197. 1982; Rani in K.M. Matthew, Fl. Tamil Nadu Carnatic 3(2): 1446. 1983; Radcl.-Sm. in Fl. Pakistan 172: 10. 1986; D.G. Long in Grierson & D.G. Long, Fl. Bhutan 3(1): 779. 1987; C.J. Saldanha, Fl. Karnataka 2: 146. 1996; A.N. Londhe in N.P. Singh et al., Fl. Maharashtra, Dicodyledons 2: 889. 2001.

— ***Phyllanthus velutinus*** (Wight) Mull.Arg. in Flora 48: 387. 1865 & in DC., Prodr. 15(2): 309. 1866.

— ***Phyllanthus nepalensis*** Mull.Arg. in Flora 48: 375. 1865 & in DC., Prodr. 15(2): 291. 1866.

— ***Phyllanthus asperus*** Mull.Arg. in Flora 48: 377. 1865 & in DC., Prodr. 15(2): 297. 1866.

— ***Glochidion asperum*** (Mull.Arg.) Bedd., Fl. Sylv. S. India Forester's Man. 193. 1873.

— ***Glochidion nepalense*** Kurz, Forest Fl. Burma 2: 344. 1877.

var. *heyneanum*

Vernacular names: Dolpoduli (Assamese), Thakha biphang or thakha mala (Bodo), Bolchiring (Garo)

Monoecious; shrub or tree, drooping branched, branchlets blackish brown, pubescent; bark brown outside, creamy yellow inside. Leaves alternate, densely pubescent beneath,

sparsely pubescent on the upper side, especially on the vein, simple, elliptic, ovate, obovate, 3–17 × 2–7 cm, acute, apiculate, obtuse at apex, acute, attenuate, obtuse at base, petiolate, stipulate, thinly coriaceous, greenish, margin entire, veins reticulate, lateral nerves 4–8 per side; petioles 0.3–0.5 cm long, pubescent, green; stipules triangular, 0.1–0.2 cm long, pubescent, green at young brown at mature and dry. Inflorescence axillary, many-flowered, rarely pedunculate. Male flowers long pedicellate, 0.9–1 cm long, sparsely pubescent, yellow; sepals 6, ovate, 0.1–0.2 cm long; anthers 3–4, 0.1–0.12 cm long, light yellow, brown. Female flowers short pedicellate, 0.3–0.5 cm long, densely pubescent, greenish to light yellow; sepals 6, ovate, lanceolate, 0.1–0.2 cm long; ovary subglobose, 4–5 locular, 0.1–0.11 cm long, pubescent, yellow-green; style columnar, 0.1–0.2 cm long, light green. Capsules depressed, subglobose, pedicellate, prominently lobed, biovulate, 4–5 locular, 1.1–1.3 cm long, numerous in the axil, pubescent, light green at young, green at mature, black or brown when dry; seeds orange at mature. **(Plate 2, Figure 3)**

Fruiting & Flowering: April – Dec.

Habitat: Evergreen and moist deciduous forests, primary forests, and *sal* forests along the roadside areas.

Distribution: India, Bangladesh, Bhutan, China, Myanmar, Nepal, Pakistan.

Specimen Examined: **INDIA. ASSAM:** Kokrajhar District, Siljan, N 26º22.925' E 090º20.262', 15-10-2020, *P. Brahma* 004 (ASSAM, Accession no. 98606); Baokhungri hill, N 26º22.868' E 090º20.315', 02-11-2020, *P. Brahma* 012; Deeplai Beel, N 26º16.45' E 090º18.47', 12-11-2020, *P. Brahma* 017; Salakati, N 26º25.803' E 090º20.825', 06-02-2021, *P. Brahma* 026.

Additional Specimen Examined: **INDIA. ASSAM:** Sibsagar District, 26-10-1912, *U. Kanjilal* 1871 (ASSAM); Kokrajhar District, Dhir, 12-06-2006, *R. Daimary* 111440 (ASSAM); **JAMMU:** 09-05-1970, *B.M. Sharma* 559 (RRLH); Palney hills, 10-1-40, *Badhwar* 5150 (RRLH); Nongpoh, 1-08-1964, *J. Joseph* 37514 (ASSAM); Meghalaya, Shillong, Kameng F.D., 14-05-1957, *R.S. Rao* 7507 (CAL0000022759: image!); Meghalaya, Mont. Khasia, *J.D. Hooker & T. Thomson* s.n. (CAL0000022801: image!); **UTTARAKANDH:** Dharasu, Tehri Garhwal, 16-06-1951, *D.D. Awasthi* 2368 (LWG), Chamoli, 01-09-1974, *K.M. Balapure* 98813 (LWG); **MADHYA PRADESH:** Pachmarhi, 19-08-1949, *S.K. Jain*, 18-08-1969 (LWG), *Hariom Saxena & A.P. Pandey* 83387 (LWG); **TAMIL NADU:** Mont. Nilgiri & Kurg, *G. Thomson* s.n. (CAL0000022799: image!);

Sikkim, *J.D. Hooker* s.n. (CAL0000022800, CAL0000023413: image!); Peninsula India, *Wight* 2575 (CAL0000022802, CAL0000022803: image!).

3. *Glochidion lanceolarium* (Roxb.) Voigt, Hort. Subrub. Calcutt. 153. 1845; Mull.Arg. in Linnaea 32: 60.1863; Bedd., Fl. Sylv. S. India Forester's Man. 192. 1873; Kurz, Forest Fl. Brit. Burma 2: 343. 1877; Hook.f., Fl., Brit. India 5: 308–309. 1890; Prain, Bengal Pl. 2: 930. 1903; T.Cooke, Fl. Bombay 2: 577. 1908; Duthie, Fl. Gangetic Plain 3: 90. 1915; Haines, Bot. Bihar Orissa 2: 131. 1921; Kanjilal et al., Fl. Assam 4: 182. 1940; Airy Shaw in Kew Bull. 26: 277. 1972; D.B. Deb, Fl. Tripura 1: 337. 1981; M.Short & A.R. Vickery in H. Hara et al., Enum. Fl. Pl. Nepal 3: 197. 1982; N.P. Balakr., Fl. Jowai 2: 421. 1983; D.G. Long in Grierson & D.G. Long, Fl. Bhutan 1(3): 780. 1987; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 214–215. 1995; A.N. Londhe in N.P. Singh et al., Fl. Maharashtra, Dicotyledons 2: 889. 2001; N.P. Balakr. & T.Chakrab., Fam. Euph. India 351. 2007; R. Daimary, Fl. Div. Kokrajhar Dist. Assam 419. 2011; Borthakur et al., Fl. BTAD 3: 76. 2018; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 229–231. 2018.

— ***Bradleia lanceolaria*** Roxb. [Hort. Bengal. 69. 1814, nom. Nud.] Fl. Ind., ed. Carey 3: 697. 1832.

— ***Phyllanthus lanceolarius*** (Roxb.) Mull. Arg. in Flora 48: 371. 1865 & in DC., Prodr. 15(2): 282. 1866.

— ***Glochidion subsessile*** N.P. Balakr. & Chakrab. subsp. *birmanicum* Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 13: 716. 1989.

Vernacular names: Panimadhuri (Assamese), Thakha biphang or thakha mala (Bodo)

Monoecious; shrubs or large trees, branched, branchlets brown or blackish, often drooping, glabrous; bark brown green outside, red inside. Leaves alternate, glabrous on both sides, simple, oblong, elliptic, lanceolate, 4–27 × 2.5–8 cm long, acuminate at apex, acute or obtuse, rounded at base, petiolate, stipulate, coriaceous, smooth, shiny, dark green on the upper side, pale green on the lower side, margin entire, veins reticulate, lateral nerves 4–8 pairs; petioles 0.6–1 cm long, glabrous, green; stipules triangular, 0.1–0.2 cm long, glabrous, green at young brownish at maturity. Inflorescence axillary, many-flowered, rarely pedunculate. Male flowers pedicellate, 0.9–2.1 cm long, glabrous, light green; sepals 6, oblong, 0.5–0.6 cm long; anthers 4–6, 0.1–0.2 cm long, light yellow, brown. Female flowers sessile, 0.1–0.3 cm long, glabrous, light green to greenish; sepals 6, ovate, oblong, elliptic, 0.2–0.3 cm long; ovary subglobose, 5–8 locular, 0.1–0.11 cm long, yellow-green;

style columnar, conical, 0.1–0.18 cm long, green. Capsules depressed, subglobose, sessile, biovulate, 5–8 locular, 1.1–1.2 cm long, one to several in the axil, smooth, sparsely pubescent, green at young, red at mature, dark brown when dry; seeds red at mature. **(Plate 3, Figure 4)**

Fruiting & Flowering: Sept. – June

Habitat: Moist deciduous forests, primary and secondary forests, and swampy areas.

Distribution: India, Bangladesh, Bhutan, Cambodia, China, Laos, Myanmar, Nepal, Thailand, Vietnam.

Specimen Examined: **INDIA. ASSAM:** Kokrajhar District, Bedlangmari, N 26º19.385' E 090º15.887', 15-01-2021, *P. Brahma* 007 (ASSAM, Accession no. 98608); Ujanpara, Ranighuli, N 26º19.848' E 090º16.113', 16-01-2021, *P. Brahma* 023.

Additional Specimen Examined: **INDIA. ASSAM:** Dawki Shillong Road, 01-10-1962, *S.L. Kapoor & Party* 75429; **SOUTH ANDAMAN:** Mount Harriet, 25-03-1961, *G. Saran Party* 88302; *s.coll.* s.n. (K000246361, K000246361: image!); **WEST BENGAL:** Hort. Bot. Calcutt., *Wallich* 7855 F (K000246361: image!); *Wallich* 7855 H (K000246362: image!); **ORISSA:** near Keonjhar, 16-03-1961, *J.G. Srivastava* 99879 (LWG); Balipohra, 01-04-1964, *S.L. Kapoor & Party* 73198 (LWG); **BIHAR:** Singhbhum, Hesadih, 13-03-1961, *J.G. Srivastava & Party* 99638 (LWG). **BANGLADESH.** Sylhet District, *Wallich* 7855 I (K001128103: image!); *Wallich* 7993 (K001128721: image!). **HONGKONG.** 1841, *R.B. Hinds* s.n. (K001081076: image!).

4. *Glochidion multiloculare* (Rottler ex Willd.) Voigt, Hort. Suburb. Calcutt. 152. 1845; Mull.Arg. in Linnaea 32: 59. 1863; Kurz, Forest Fl. Brit. Burma 2: 343. 1877; Hook.f., Fl. Brit. India 5: 307. 1890; Prain, Bengal Pl. 2: 930. 1903; Duthie, Fl. Gangetic Plain 3: 89. 1915; Haines, Bot. Bihar Orissa 2: 130. 1921; Kanjilal et al., Fl. Assam 4: 181. 1940; D.B. Deb, Fl. Tripura 1: 337. 1981; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 217–218. 1995; Bora & Kumar, Fl. Div. Assam 304. 2005; N.P. Balakr. & T.Chakrab., Fam. Euph. India 351. 2007; R. Daimary, Fl. Div. Kokrajhar Dist. Assam 419–420. 2011; Borthakur et al., Fl. BTAD 3: 74–77. 2018; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 232–233. 2018.

— ***Agyneia multilocularis*** Rottler ex Willd. in Ges. Naturf. Freunde Berlin Neue Schriften 4: 206. 1803 & Sp. Pl. ed. 4, 4(1): 569. 1805.

— ***Bradleia multiloculare*** (Rottler ex Willd.) Spreng., Syst. Veg. 3: 19. 1826; Roxb., Fl. Ind., ed. Carey 3: 696. 1832.

— ***Phyllanthus multilocularis*** (Rottler ex Willd.) Mull.Arg. in Flora 48: 370. 1865 & in DC., Prodr. 15(2): 279. 1866.

Key to the varieties

1a. Almost whole plant body are glabrous except

their reproductive body and immature leaves with

several capsules in each axil……...**4.1.** var. ***multiloculare***

1b. All parts of the plant body are pubescent, solitary

capsules in each axil……..**4.2.** var. ***pubescens***

4.1. var. ***multiloculare***

Vernacular names: Garumora, Dolpodhuli (Assamese), Thakha biphang or thakha mala (Bodo)

Monoecious; mostly shrub or medium size tree, branched, branchlets brown or blackish, glabrous; bark brown outside, greenish-white inside. Leaves alternate, simple, oblong, elliptic, ovate, green to yellow red at young, 4–16 × 2–6 cm, acute to apiculate at apex, acute or rounded at base coriaceous, glabrous on both sides, curling upwards and margins when dry, dark green, petiolate, stipulate, margin entire, veins reticulate, lateral nerves 5–13 per side; petioles 0.4–0.5 cm long, glabrous, green; stipules triangular, 0.1–0.2 cm long, glabrous, green at young brown at mature and dry. Inflorescence axillary, many-flowered, irregularly pedunculate. Male flowers long pedicellate, many-flowered, 0.7–1 cm long, glabrous, yellow-green; sepals 6, oblong, ovate, 0.1–0.2 cm long; anthers 5–12, 0.1–0.11 cm long, light yellow, brown. Female flowers pedicellate, shorter than male flowers, many-flowered in the axil, 0.3–0.5 cm long, mostly glabrous or sparsely pubescent, yellow-green; sepals 6–12, ovate, oblong or lanceolate, 0.1–0.2 cm long; ovary depressed, 5–12 locular, 0.1–0.2 cm long, sparsely pubescent, yellow-green; styles distinct, conical or arranged in a ring, 0.1–0.11 cm long, yellow-green. Capsules depressed, subglobose, pedicellate, deeply lobed, biovulate, 5–12 locular, 0.5–1 cm long, numerous in the axil, glabrous or sparsely pubescent, green at young, dark green at mature, brown to blackish after dry; seeds orange to red at mature. **(Plate 4, Figure 5)**

Fruiting & Flowering: Jan. – Dec.

Habitat: Swampy areas along streamside, deciduous forests, *sal* forests along roadside, grassland.

Distribution: India, Bangladesh, Bhutan, China, Myanmar, Nepal.

Specimen Examined: **INDIA. ASSAM:** Kokrajhar District, Debargaon, N 26º29.902' E 090º20.351', 20-06-2020, *P. Brahma* 002 (ASSAM, Accession no. 98604); Sutarpara, N 26º27.962' E 090º17.940', 23-08-2020, *P. Brahma* 011; Simbargaon, N 26º29.617' E 090º15.341', 07-11-2020, *P. Brahma* 013; Baksa District, Manas National Park, N 26º42.174' E 090º59.968', 11-11-2020, *P. Brahma* 014; Kokrajhar District, Raimona National Park, N 26º43.789' E 090º08.988', 02-12-2020, *P. Brahma* 018; Dimalgaon, N 26º25.480' E 090º16.311', 04-12-2020, *P. Brahma* 019; Ultapani Forest Range, N 26º38.539' E 090º17.397', 07-12-2020, *P. Brahma* 020; Karbi Anglong District, Silveta, N 25º59.741' E 093º18.617', 25-12-2020, *P. Brahma* 021; Salakati, N 26º25.803' E 090º20.823', 06-02-2021, *P. Brahma* 025; Udalguri District, Orang National Park, N 26º32.98' E 092º17.065', 25-12-2021, *P. Brahma* 034; Kokrajhar District, Owabari, Daolur dwisa, N 26º36.946' E 090º18.801', 29-05-2022, *P. Brahma* 036; Golaghat District, Kaziranga National Park, Kohora Range, N 26º39.319' E 093º21.306', 07-10-2022, *P. Brahma* 039; Sonitpur District, Nameri National Park, N 26º56.588' E 092º51.310', 06-01-2023, *P. Brahma* 045.

Additional Specimen Examined: **INDIA. ASSAM:** Nowgong District, 05-11-1913, *U. Kanjilal* 2861 (ASSAM); Barpathar, 20-06-1963, *D.B. Deb* 35210 (ASSAM); Kamrup district, 21-10-1965, *A.S. Rao* 42424 (ASSAM); Kokrajhar District, Chakrashila Wildlife Sanctuary, 07-08-2007, *R. Daimary* 110692 (ASSAM); **UTTAR PRADESH:** Kishanpur Wildlife Sanctuary, 11-07-2018, *T. Hussain, P. Agnihotri & P. Kaliyan* 305586 (LWG); **WEST BENGAL:** Hort. Calcutt., *Wallich* 7864 B (K000246357: image!), *Wallich* 7864 E (K000246359: image!), *W. Roxburgh* (K000246356: image!); *W. Griffith* s.n. (K000246358: image!).

4.2. var. ***pubescens*** Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 14:720. 1990; N.P. Balakr. & T.Chakrab., Fam. Euph. India 351. 2007; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 233. 2018.

Vernacular names: Thakha biphang or thakha mala (Bodo)

Monoecious; shrub or small tree, pubescent branched, branchlets brown or blackish; bark brown outside, greenish-white inside. Leaves alternate, simple, oblong, elliptic, ovate, 4–15 × 2–6 cm, acute to apiculate at apex, acute or rounded at base, curling upwards and margins when dry, coriaceous, pubescent on both sides, densely pubescent on the lower side, slightly red to yellow-green at young, green at mature, brown when dry, petiolate, stipulate, margin entire, veins reticulate, lateral nerves 5–13 per side; petioles 0.4–0.5 cm long, pubescent, green; stipule triangular 0.17–0.2 cm long, pubescent, green at young brown at mature and dry. Inflorescence axillary, single to many flowered, irregularly pedunculate. Male flowers pedicellate, 0.5–1 cm long, pubescent, yellow-green, many-flowered in each axil; sepals 6, oblong, ovate, 0.1–0.2 cm long; anthers 5–12, 0.1–0.11 cm long, light yellow, brown. Female flowers pedicellate, shorter than male flowers, 0.3–0.5 cm long, single in the axil, densely pubescent, yellow-green; sepals 7–12, ovate, oblong or lanceolate, 0.1–0.2 cm long; ovary depressed, 5–12 locular, 0.1–0.2 cm long, densely pubescent, yellow-green; styles conical or arranged in a ring, 0.1–0.11 cm long, green. Capsules depressed, subglobose, pedicellate, deeply lobed, biovulate, 5–12 locular, 0.5–1 cm long, single in the axil, densely pubescent, green at young, dark green at mature, brown red at the top, brown to blackish after dry; seeds red at mature. **(Plate 5, Figure 6)**

Fruiting & Flowering: Jan. – Dec.

Habitat: Swampy areas along streamside, deciduous forests, *sal* forests along roadside, grassland.

Distribution: India (Sikkim & Assam: Endemic).

Specimen Examined: **INDIA. ASSAM:** Udalguri District, Orang National Park, N 26º32.909' E 092º17.170', 25-12-2021, *P. Brahma* 009 (ASSAM, Accession no. 98610); Sonitpur District, Nameri National Park, N 26º56.570' E 092º51.305', 06-01-2023, *P. Brahma* 048.

Additional Specimen Examined: **INDIA. ASSAM:** Nowgong District, 05-11-1913, *U. Kanjilal* 2861 (CAL0000022761: image!); **SIKKIM:** *S. Kurz* (CAL0000022760: image!).

Notes: *G. multiloculare* var. *pubescens* Chakrab. & M.Gangop. is endemic to Sikkim and Assam (Chakrabarty & Balakrishnan, 2018). The habit characters, distribution, and morphology of *G. multiloculare* var. *pubescens* are exactly the similar as the species *G. multiloculare* (Rottler ex Willd.) Voigt var. *multiloculare*. The only difference is that the

whole body of *G. multiloculare* var. *pubescens* is covered with hair i.e., pubescent and their reproductive parts arise single in the axil and the whole body of *G. multiloculare* var. *multiloculare* is glabrous except their reproductive structure i.e., flowers and fruits and they are single to many arise in the axil.

5. *Glochidion sphaerogynum* (Mull.Arg.) Kurz, Forest Fl. Brit. Burma 2: 346. 1877; Hook.f., Fl. Brit. India 5: 317. 1887; Prain, Bengal Pl. 2: 931. 1903; Kanjilal et al., Fl. Assam 4: 188. 1940; Airy Shaw in Kew Bull. 26: 280. 1972; D.B. Deb, Fl. Tripura 1: 337. 1981; D.G. Long in Grierson & D.G. Long, Fl. Bhutan 1(3): 781. 1987; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 223–224. 1995; N.P. Balakr. & T.Chakrab., Fam. Euph. India 352. 2007; R. Daimary, Fl. Div. Kokrajhar Dist. Assam 420. 2011; Borthakur et al., Fl. BTAD 3: 77. 2018; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 242–243. 2018.

— ***Phyllanthus sphaerogynus*** Mull.Arg. in Flora 48: 375. 1865 & in DC., Prodr. 15(2): 293. 1866.
— ***Phyllanthus fagifolius*** Mull.Arg. in Flora 48: 373. 1865 & in DC., Prodr. 15(2): 288. 1866.
— ***Glochidion fagifolium*** (Mull.Arg.) Miq. ex Bedd., Fl. Sylv. S. India Forester's Man. 193. 1873.

Vernacular names: Panimadhuri (Assamese), Thakha biphang or thakha mala (Bodo), Boljakru (Garo)

Monoecious; medium size or large tree, drooping branched, branchlets brown, glabrous; bark brown outside, creamy white inside. Leaves oblong, elliptic, lanceolate, ovate, entirely glabrous, alternate, simple, 3–23 × 1.5–5.3 cm, acuminate at apex, attenuate or acute at base, petiolate, stipulate, coriaceous, green at young, dark green, glossy, red at mature, margin entire, veins reticulate, lateral nerves 10 per side; petioles short, thick, 0.9–1 cm long, glabrous, green, brown; stipule triangular, 0.1–0.2 cm long, glabrous, green at young, brown at mature and dry. Inflorescence axillary, many-flowered. Male flowers long pedicellate, 1.5–1.7 cm long, glabrous, green at young, brown or blackish when dry; sepals 6, spathulate, 0.2–0.4 cm long; anthers 3–5, 0.1–0.15 cm long, light yellow, brown. Female flowers short pedicellate, 0.3–0.5 cm long, glabrous, green; sepals 6, obovate, 0.19–0.2 cm long; ovary subglobose, depressed, 4–6 locular, 0.1–0.2 cm long, glabrous, green; style subglobose, 0.1–0.2 cm long, yellow-green. Capsules depressed, subglobose, short

pedicellate, prominently lobed, biovulate, 4–12 lobed, 0.4–0.8 cm long, numerous in the axil, glabrous, green at young, dark green at mature, dark brown or black when dry; seeds red, brown at mature. **(Plate 6, Figure 7)**

Fruiting & Flowering: Jan. – Dec.

Habitat: Hilly areas, evergreen forest, the primary forest along the roadside.

Distribution: India, Bangladesh, Bhutan, China, Myanmar, Nepal, Thailand, Vietnam.

Specimen Examined: **INDIA. ASSAM:** Kokrajhar District, Salbari, Chakrashila Wildlife Sanctuary, N 26º17.025' E 090º21.089', 26-01-2021, *P. Brahma* 008 (ASSAM, Accession no. 98609); Salbari, N 26º17.473' E 090º19.706', 26-01-2021, *P. Brahma* 024; Bandalmuri, N 26º19.867' E 090º17.971', 09-11-2021 *P. Brahma* 031; Cachar District, Barail Wildlife Sanctuary, N 25º01.841' E 092º34.423', 20-03-2021, *P. Brahma* 029; Sonitpur District, Balipara Reserve Forest, N 26º56.014' E 092º47.931', 05-01-2023, *P. Brahma* 044.

Additional Specimen Examined: **INDIA. SIKKIM & BHUTAN:** *W. Griffith* 271 (K000246388: image!).

6. *Glochidion zeylanicum* (Gaertn.) A.Juss., Euphorb. Gen. 107, t. 3. 1824; Baill., Etude Euphorb. 638. 1858; Thwaites, Enum. Pl. Zeyl. 285. 1861; Bedd., Fl. Sylv. S. India Forester's Man. 192. 1873; Hook.f., Fl. Brit. India 5: 310. 1890; Haines, Bot. Bihar Orissa 2: 132. 1921; Gamble, Fl. Madras 2(7): 1306. 1925; Kanjilal et al., Fl. Assam 4: 183. 1940; D.B. Deb, Fl. Tripura 1: 338. 1981; Rani in K.M. Matthew, Fl. Tamil Nadu Carnatic 3(2): 1446. 1983; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 226–228. 1995; C.J. Saldanha, Fl. Karnataka 2: 146. 1996; A.N. Londhe in N.P. Singh et al., Fl. Maharashtra, Dicotyledons 2: 890. 2001; S.S. Preetha, Fl. Kerala 172–174. 2007; N.P. Balakr. & T.Chakrab., Fam. Euph. India 353–354. 2007; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 248–255. 2018.

— ***Bradleia zeylanica*** Gaertn., Fruct. Sem. Pl. 2: 128, t. 109. 1791.
— ***Phyllantus zeylanicus*** (Gaertn.) Mull.Arg. in DC., Prodr. 15(2): 181. 1866.
— ***Glochidion nitidum*** (Roxb.) Voigt, Hort. Suburb. Calcutt. 153. 1845; Dalzell & A.Gibson, Bombay Fl. 235. 1861; Bedd., Fl. Sylv. S. India Forester's Man. 192. 1873.
— ***Phyllanthus nitidus*** (Roxb.) Mull.Arg. in Flora 48: 371. 1865 & in Dc., Prodr. 15(2): 282. 1866.

— ***Glochidion zeylanicum*** (Gaertn.) A.Juss. var. ***nitidum*** (Roxb.) Haines, Bot. Bihar Orissa 2: 132. 1921.

— ***Phyllanthus canaranus*** Mull.Arg. in Flora 48: 371. 1865 & in DC., Prodr. 15(2): 284. 1866.

— ***Glochidion canaranum*** (Mull.Arg.) Bedd., Fl. Sylv. S. India Forester's Man. 192. 1873.

— ***Glochidion brunneum*** Hook.f., subsp. ***andamanicum*** N.P. Balakr. & Chakrab. in Proc. Indian Acad. Sci. (Plant Sci.) 92(4): 357. 1983; Chakrab. & N.P. Balakr. in J. Econ. Taxon. Bot., Addit. Ser. 9: 70. 1992.

— ***Glochidion sumatranum*** sensu N.P. Balakr. & Chakrab. in Proc. Indian Acad. Sci. (Pl. Sci.) 92(4): 361. 1983, non Miq., 1861.

— ***Glochidion hongkongense*** sensu Chakrab. & N.P. Balakr. in J. Econ. Taxon. Bot. 13: 712. 1989, non Mull. Arg. 1863.

Key to the varieties

1a. Whole portions of the plant body are glabrous…….……**6.4.** var. ***zeylanicum***

1b. Whole portions of the plant body are pubescent……...**2**

2a. Capsules conspicuously unlobed…….**6.1.** var. ***arborescens***

2b. Capsules ambiguously lobed……**3**

3a. Female flower and capsule single in each axil……**6.2.** var. ***paucicarpum***

3b. Female flower and capsule several in each axil…….**6.3.** var. ***tomentosum***

6.1. var. ***arborescens*** (Blume) Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 228–229. 1995; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 251–252. 2018.

— ***Glochidion arborescens*** Blume, Bijdr. Fl. Ned. Ind. 584. 1826; Kanjilal et al. Fl. Assam 4: 188. 1940; Airy Shaw in Kew Bull. 26: 273. 1972 & 36: 301. 1981; Welzen in Welzen & Chayam., Fl. Thailand 8(2): 313. 2007; R. Daimary, Fl. Div. Kokrajhar Dist. Assam 417–418. 2011; Borthakur et al., Fl. BTAD 3: 74. 2018.

— ***Phyllanthus arborescens*** (Blume) Mull.Arg. in Flora 48: 370. 1865 & in DC., Prodr. 15(2): 279. 1866.

— ***Phyllanthus zeylanicus*** (Gaertn.) Mull.Arg. var. ***arborescens*** (Blume) Chakrab. & N.P. Balakr. in J. Econ. Taxon. Bot. 33: 714. 2009.

— ***Glochidion bancanum*** Miq., Fl. Ned. Ind., Eerste Bijv. 180, 450. 1861; Kurz, Forest Fl. Burma 2: 347. 1877.

— ***Phyllanthus silheticus*** Mull.Arg. in Flora 48: 378. 1865 & in DC., Prodr. 15(2): 297. 1866.

— ***Phyllanthus obliquus*** (Willd.) Mull.Arg. var. ***mollis*** Mull.Arg. in DC., Prodr. 15(2): 284. 1866.

Vernacular names: Panimadhuri (Assamese), Thakha biphang or thakha mala (Bodo)

Monoecious; shrub or large tree, branched, branchlets brown, thick, pubescent; bark brown outside, red inside. Leaves alternate, simple, densely pubescent on the dorsal side, sparsely pubescent on the upper or ventral side, especially on the vein, chartaceous, slightly coriaceous, rough, ovate, yellow-green to red, purplish at young, acute at apex, obtuse or rounded at base, 5–25 × 1.5–8.5 cm, petiolate, stipulate, green or reddish, covered with algae species when mature, margin entire, veins reticulate, lateral nerves 6–11 per side; petioles 0.3–0.5 cm long, pubescent, red; stipules triangular, 0.18–0.2 cm long, pubescent, green at young brown at mature and dry. Inflorescence axillary to supra-axillary, dense flowered, pedunculate. Male flowers long pedicellate, 0.5–0.7 cm long, creamy or light green, pubescent; sepals 6, ovate, 0.16–0.2 cm long; anthers 3–5, 0.1–0.12 cm long, light yellow, brown. Female flowers short pedicellate, 0.4–0.6 cm long, green or reddish, densely pubescent; sepals 6, ovate, oblong, 0.1–0.12 cm long; ovary subglobose, 4–6 locular, 0.1–0.2 cm long, pubescent, yellow-green to reddish; style persistent, united, conical, 0.5–0.8 cm long, yellow. Capsule globose, pedicellate, prominently unlobed, biovulate, 4–6 locular, 1–1.2 cm long, numerous in the axil, creamy or green at young, pinkish or reddish at mature, brown when dry, pubescent; seed orange to red at mature. **(Plate 7, Figure 8)**

Fruiting & Flowering: April – Feb.

Habitat: Evergreen and deciduous forests, primary forests, swampy areas, streamside areas.

Distribution: India, Bangladesh, Malaysia, Myanmar, Thailand.

Specimen Examined: **INDIA. ASSAM:** Kokrajhar District, Ultapani Forest Range, N 26º46.1212' E 090º17.2288', 21-12-2019, *P. Brahma* 001 (ASSAM, Accession no. 98603); Karigaon, N 26º32.873' E 090º20.610', 26-11-2020, *P. Brahma* 016; Karbi Anglong

District, Kangthilangso, N 26º15.992' E 093º51.546', 26-12-2020, *P. Brahma* 022; Kokrajhar District, Ranighuli, N 26º19.404' E 090º15.834', 18-02-2021, *P. Brahma* 027; Owabari, Daolur dwisa, N 26º19.956' E 090º18.811', 29-05-2022, *P. Brahma* 035; Sonitpur District, Balipara Reserve Forest, N 26º55.928' E 092º47.714', 05-01-2023, *P. Brahma* 040.

Additional Specimen Examined: **INDIA. ASSAM:** Sibsagar District, 16-02-1914, *U. Kanjilal* 26514 (ASSAM); Lakhimpur District, 17-02-1914, *U. Kanjilal* 3440 (ASSAM); Goalpara District, 04-07-1915, *U. Kanjilal* 5077 (ASSAM); Assam, 09-07-1959, *G. Panigrahi* 18892 (ASSAM); Nowgong District, 25-08-1964, *N.P. Balakrishnan* 39425 (ASSAM); Lakhimpur District, Dulung Reserve Forest, 07-05-2011, *N. Odyuo* 122376 (ASSAM); **Andaman & Nicobar Islands:** South Andamans, Baratang Island, 22-01-1979, *P. Basu* 7326 (PBL0000018423: image!). **BANGLADESH.** Sylhet District, 04-12-1850, *J.D. Hooker* & *T. Thomson* s.n. (K001081203: image!); 05-12-1850, *J.D. Hooker* & *T. Thomson* s.n. (K001081204: image!).

Notes: Leaves are finely covered with algae at maturity.

6.2. var. ***paucicarpum*** Chakrab. & N.P. Balakr. in J. Econ. Taxon. Bot. 28: 123, t. 1. 2004; N.P. Balakr. & T.Chakrab., Fam. Euph. India 354. 2007; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 252. 2018.

Vernacular names: Thakha biphang or thakha mala (Bodo)

Monoecious; shrub or medium size tree, branched, branchlets dark green to brown, entirely pubescent; bark dark brown outside, whitish yellow or brownish red inside. Leaves alternate, simple, smooth, densely pubescent on the lower surface, coriaceous, thick, broad, elliptic, ovate, lanceolate, 6–22 × 4–8 cm, acute at apex, obtuse, truncate, symmetric rarely oblique, rounded at base, petiolate, stipulate, green, margin entire, veins reticulate, lateral nerves 6–10 per side; petioles 0.9–1 cm long, sparsely pubescent, green; stipules triangular, 0.2–0.4 cm long, sparsely pubescent, green at young brown at mature and dry. Inflorescence supra-axillary, few-flowered, pedunculate. Male flowers white, pubescent. Female flowers single, supra-axillary, pedicellate, 0.9–1 cm long, pubescent, green, brown; sepals 3, obovate, 0.3–0.5 cm long; ovary subglobose, 4–8 locular, 0.5–0.8 cm long, pubescent, yellow-green; style persistent, columnar, conical, 0.1–0.12 cm long, green, brown, tomentose. Capsules subglobose, pedicellate, unlobed, biovulate, 8 locular, 1.5–2

cm long, single in each axil, tomentose, green or light yellow-green at young, green and slightly purplish red at the top at mature; seeds orange to red. **(Plate 8, Figure 9)**

Flowering: Dec. – Aug.

Habitat: Semi-evergreen and moist deciduous forests, primary forests, swampy areas, and streamside areas at about 76 m altitude.

Distribution: India (Andaman & Nicobar Islands: Endemic), Assam (Brahma & Baruah, 2023).

Specimen Examined: **INDIA. ASSAM:** Kokrajhar District, Owabari, Daolur dwisa, near Ultapani Forest Range, N 26º37.131' E 090º18.784', 29-05-2022, *P. Brahma* 010 (ASSAM, Accession no. 099973).

Additional Specimen Examined: **INDIA.** Andaman & Nicobar Islands, Middle Andaman Island, Jarawa Reserve, ATR, 1 km before Dhani Nala, 17-08-2002, *T. Chakrabarty* 19160 A (*holotype* CAL, CAL0000022754: image!) 19160 B, C, D, E (*isotypes* CAL, CAL0000022739: image!, CAL0000022740: image!, CAL0000022741: image!, CAL0000022738: image!).

Notes: This is the first distributional record from Assam including North East India. *G. zeylanicum* has a total of four varieties including itself viz., *G. zeylanicum* var. *zeylanicum*, *G. zeylanicum* var. *arborescens*, *G. zeylanicum* var. *tomentosum* and *G. zeylanicum* var. *paucicarpum*. Among them, *G. zeylanicum* var. *paucicarpum* closely resembles *G. zeylanicum* var. *tomentosum* by its pubescent plant body and the morphological structure of the capsule but differs by the presence of a single female inflorescence and capsule in each axil.

6.3. var. ***tomentosum*** Trimen, Handb. Fl. Ceylon 4: 29. 1898; Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 19(1): 205–208. 1995; S.S. Preetha, Fl. Kerala 173. 2007; N.P. Balakr. & T.Chakrab., Fam. Euph. India 354. 2007; T.Chakrab. & N.P. Balakr., Indo-Bur. Phy. 252–254. 2018.

— ***Glochidion hirsutum*** (Roxb.) Voigt, Hort. Suburb. Calcutt. 153. 1845; Mull.Arg. in Linnaea 32: 61. 1863; Hook.f., Fl. Brit. India 5: 311. 1887; Prain, Bengal Pl. 2: 931. 1903; C.E. Parkinson, Forest Fl. Andaman Isl. 233. 1923; Kanjilal et al., Fl. Assam 4: 184. 1940; Airy Shaw in Kew Bull. 26: 275. 1972; D.G. Long in Grierson & D.G.

Long, Fl. Bhutan 1(3): 778. 1987; A.N. Londhe in N.P. Singh et al., Fl. Maharashtra, Dicotyledons 2: 888. 2001; Welzen in Welzen & Chayam., Fl. Thailand 8(2): 319. 2007; R. Daimary, Fl. Div. Kokrajhar Dist. Assam 419. 2011; Borthakur et al., Fl. BTAD 3: 76. 2018.

— ***Phyllanthus hirsutus*** (Roxb.) Mull.Arg. in Flora 48: 371. 1865 & in DC., Prodr. 15(2): 283. 1866.

— ***Glochidion tomentosum*** Dalzell in Hooker's J. Bot. Kew Gard. Misc. 3: 38. 1851; Bedd., Fl. Sylv. S. India Forester's Man. 192. 1873; Hook.f., Brit. India 5: 309. 1887; T.Cooke, Fl. Bombay 2(3): 577. 1906; Gamble, Fl. Madras 2(7): 1306. 1925; C.J. Saldanha, Fl. Karnataka 2: 146. 1996; A.N. Londhe in N.P. Singh et al., Fl. Maharashtra, Dicotyledons 2: 889. 2001.

— ***Phyllanthus tomentosus*** (Dalzell) Mull.Arg. in Flora 48: 371. 1865 & in DC., Prodr. 15(2): 283. 1866.

— ***Phyllanthus zeylanicus*** (Gaertn.) Mull.Arg. var. ***tomentosus*** (Dalzell) Chakrab. & N.P. Balakr. in J. Econ. Taxon. Bot. 33: 714. 2009.

— ***Glochidion tomentosum*** Dalzell var. ***talbotii*** Hook.f., Fl. Brit. India 5: 311. 1887.

— ***Glochidion zeylanicum*** (Gaertn.) A.Juss. var. ***talbotii*** (Hook.f.) Haines, Bot. bIhar Orissa 2: 132. 1921.

— ***Glochidion hongkongense*** Mull.Arg. var. ***puberulum*** Chakrab. & M.Gangop. in J. Econ. Taxon. Bot. 13: 712, f. 2. 1989.

— ***Glochidion montanum*** sensu Bahadur et al. in Indian Forester 99: 624. 1973, non Thwaites, 1861.

Vernacular names: Panimadhuri (Assamese), Thakha biphang or thakha mala (Bodo)

Monoecious; shrub or medium size tree, branched, branchlets dark green to brown, pubescent; bark dark brown outside, red inside. Leaves alternate, simple, smooth, densely pubescent on both surfaces, coriaceous, thick, yellow-green to red at young, broad, elliptic, ovate, cordate, 5–20 × 3–8 cm, acute, obcordate at apex, cordate, obtuse, truncate, oblique or asymmetric at base, petiolate, stipulate, green, margin entire, veins reticulate, lateral nerves 5–10 per side; petioles 0.5–0.7 cm long, pubescent, red on the ventral side green on the dorsal side; stipules triangular, 0.2–0.3 cm long, pubescent, green at young brown at mature and dry. Inflorescence mostly supra-axillary and rarely axillary, many-flowered, pedunculate. Male flowers long pedicellate, 0.7–1.8 cm long, sparsely pubescent, yellowish red, brown; sepals 6, spathulate, 0.1–0.2 cm long; anthers 3–7, 0.1–0.2 cm long,

light yellow, brown. Female flowers short pedicellate, 0.4–1 cm long, densely pubescent, green; sepals 6, obovate, 0.1–0.11 cm long; ovary subglobose, 5–8 locular, 0.1–0.11 cm long, pubescent, yellow-green to reddish brown; style not persistent, columnar, conical, 0.09–0.1 cm long, tomentose, green, red. Capsules subglobose, pedicellate, unlobed, biovulate, 5–8 locular, 0.5–1.5 cm long, numerous in the axil, tomentose, green or light yellow-green at young, green and reddish at the top in mature; seeds orange or red at mature. **(Plate 9, Figure 10)**

Fruiting & Flowering: April – Feb.

Habitat: Evergreen and deciduous forests, primary forests, swampy areas, streamside areas.

Distribution: India, Bangladesh, Bhutan, China, Myanmar, Sri Lanka, Thailand.

Specimen Examined: **INDIA. ASSAM:** Kokrajhar District, Ultapani Forest Range, N 26º46.020' E 090º17.477', 24-11-2020, *P. Brahma* 005 (ASSAM, Accession no. 98607); Owabari, Daolur dwisa, N 26º36.956' E 090º18.811', 29-05-2022, *P. Brahma* 037; Sonitpur District, Balipara Reserve Forest, N 26º55.902' E 092º47.762', 05-01-2023, *P. Brahma* 042; Nameri National Park, N 26º56.555' E 092º51.310', 06-01-2023, *P. Brahma* 047.

Additional Specimen Examined: **INDIA.** *J.E. Stocks & J.S. Law* 13 (K000246367, K000246370: image!); 18-05-1883, *W.A. Talbot* 481 (K000246368: image!), *N.A. Dalzel* s.n. (K000246366: image!). **SRI LANKA.** *G.H.K. Thwaites* s.n. (K001081200: image!); *s.coll.* s.n. (K001081201: image!). **HONGKONG.** 1853, *C. Wright* 498 (K001081079: image!); 12-1857, *C. Wilford* 47 (K001081078: image!); *s.coll.* 469 (K001081081: image!); *H.F. Hance* s.n. (K001081080: image!).

6.4. var. ***zeylanicum***

Vernacular names: Panimadhuri (Assamese), Thakha biphang or thakha mala (Bodo), Longlisilu (Karbi)

Monoecious; shrub, drooping branched, branchlets green to brown, glabrous; bark brown outside, creamy white to slightly reddish inside. Leaves alternate, simple, glabrous, thick, large, coriaceous, broad, oblong to elliptic, ovate, suborbicular, 8–20 × 5–8 cm, apiculate, acute at apex, asymmetric, cordate at base, petiolate, stipulate, smooth, green, margin entire, veins reticulate, lateral nerves 4–10 per side; petioles 0.8–1 cm long, glabrous,

green; stipules triangular, 0.1–0.12 cm long, glabrous, green at young brown at mature and dry. Inflorescence axillary to supra-axillary, many-flowered, pedunculate. Male flowers long pedicellate, 0.4–0.9 cm long, glabrous, yellowish red, brown; sepals 3–5, ovate, obovate, 0.1–0.3 cm long, anthers 3–8, 0.1–0.11 cm long, light yellow, brown. Female flowers short pedicellate, 0.1–0.2 cm long, glabrous, light yellow, green; sepals 6, ovate, obovate, 0.12–0.15 cm long; ovary subglobose, 4–8 locular, 0.1–0.11 cm long, yellow-green, brown to red; style columnar, conical, 0.5–0.9 cm long, yellow to green. Capsules subglobose, pedicellate, unlobed, biovulate, 4–8 locular, 0.9–1cm long, numerous in the axil, glabrous, green at young, brown or red at mature, black when dry; seeds red at mature. **(Plate 10, Figure 11)**

Fruiting & Flowering: Jan. – Dec.

Habitat: Hilly areas, evergreen forests, swampy areas, streamside, primary forests area.

Distribution: India, Bangladesh, Malaysia, Myanmar, Thailand.

Specimen Examined: **INDIA. ASSAM:** Karbi Anglong District, Nokpakghat, N 26º16.422' E 093º03.562', 26-12-2020, *P. Brahma* 006 (ASSAM, Accession no. 98611); Kokrajhar District, Owabari, Daolur dwisa, N 26º36.956' E 090º18.811', 29-05-2022, *P. Brahma* 038; Sonitpur District, Balipara Reserve Forest, N 26º55.629' E 092º47.600', 05-01-2023, *P. Brahma* 043.

Additional Specimen Examined: **INDIA.** *s.coll.* s.n. (K001081197, K001081199: image!).

Notes: *Glochidion zeylanicum* var. *zeylanicum* almost consists of similar morphological characters compared to *Glochidion zeylanicum* var. *tomentosum*. But it can be differentiated by its hairy habit i.e., *Glochidion zeylanicum* var. *zeylanicum* shows an entirely glabrous plant body and *Glochidion zeylanicum* var. *tomentosum* consists of an entirely pubescent plant body.

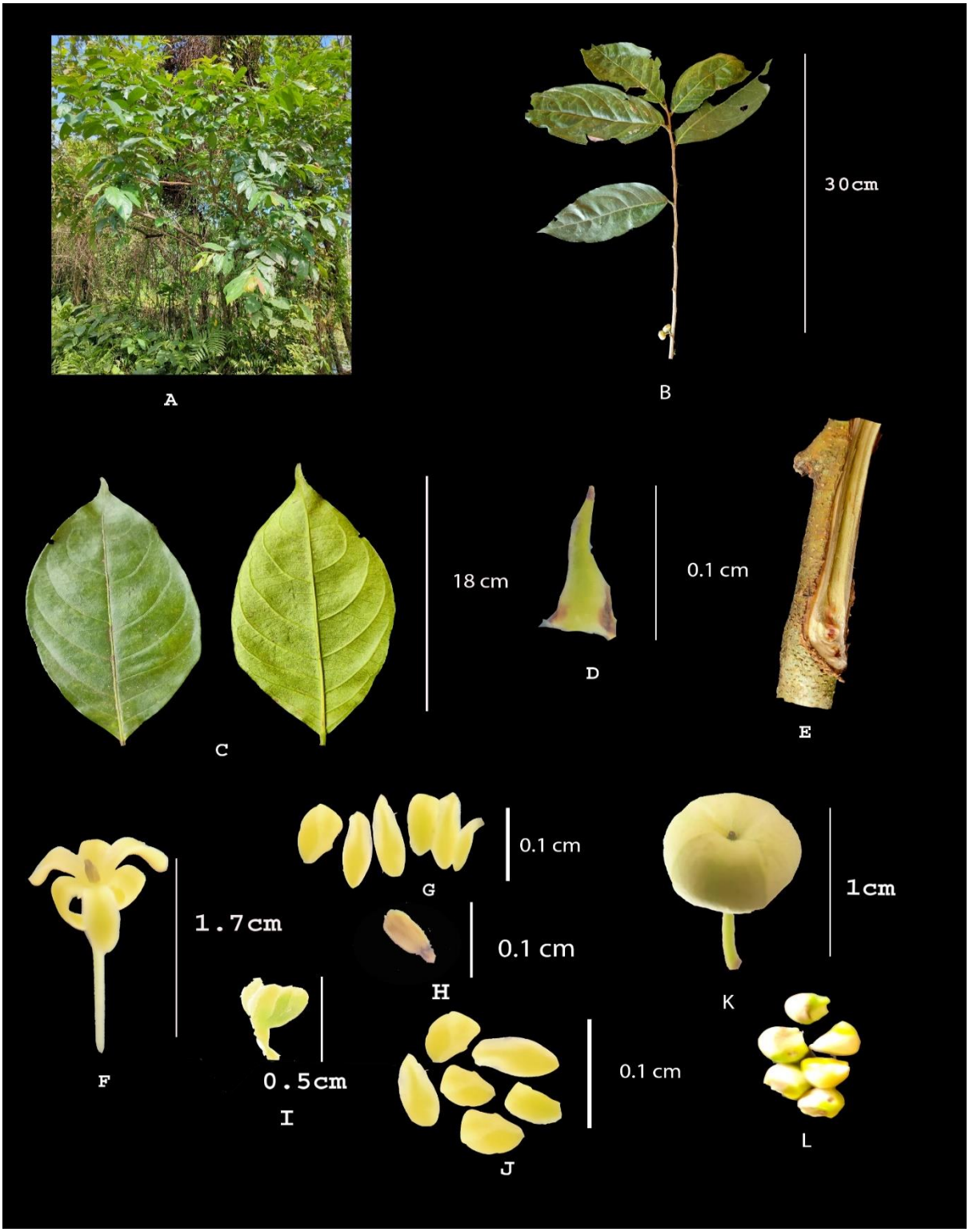

Plate 1. ***Glochidion ellipticum*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** Bark of stem branch; **F.** A male flower; **G.** Sepals; **H.** Anther; **I.** A female flower; **J.** Sepals; **K.** A capsule; **L.** Seeds.

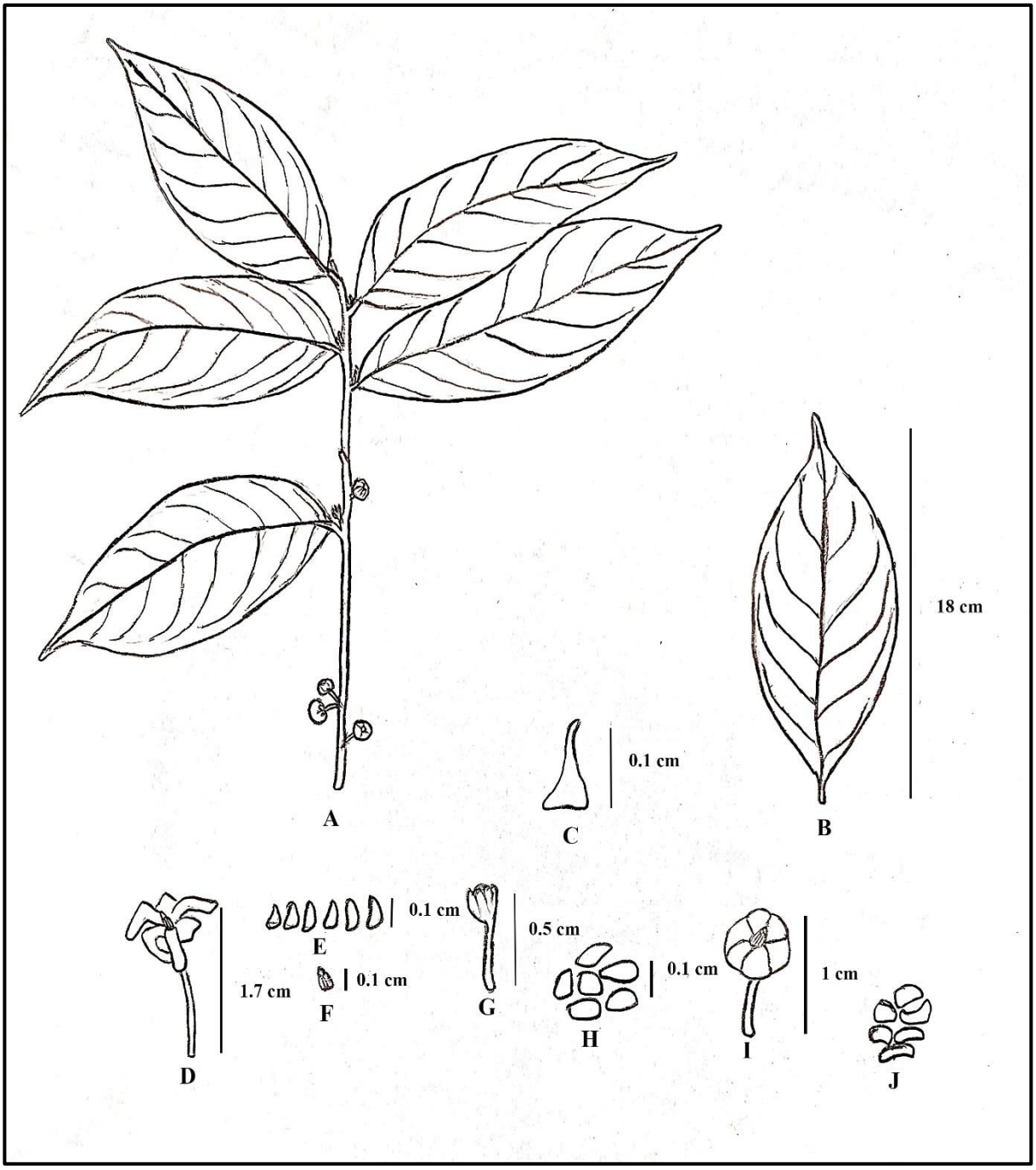

Figure 2. ***Glochidion ellipticum*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

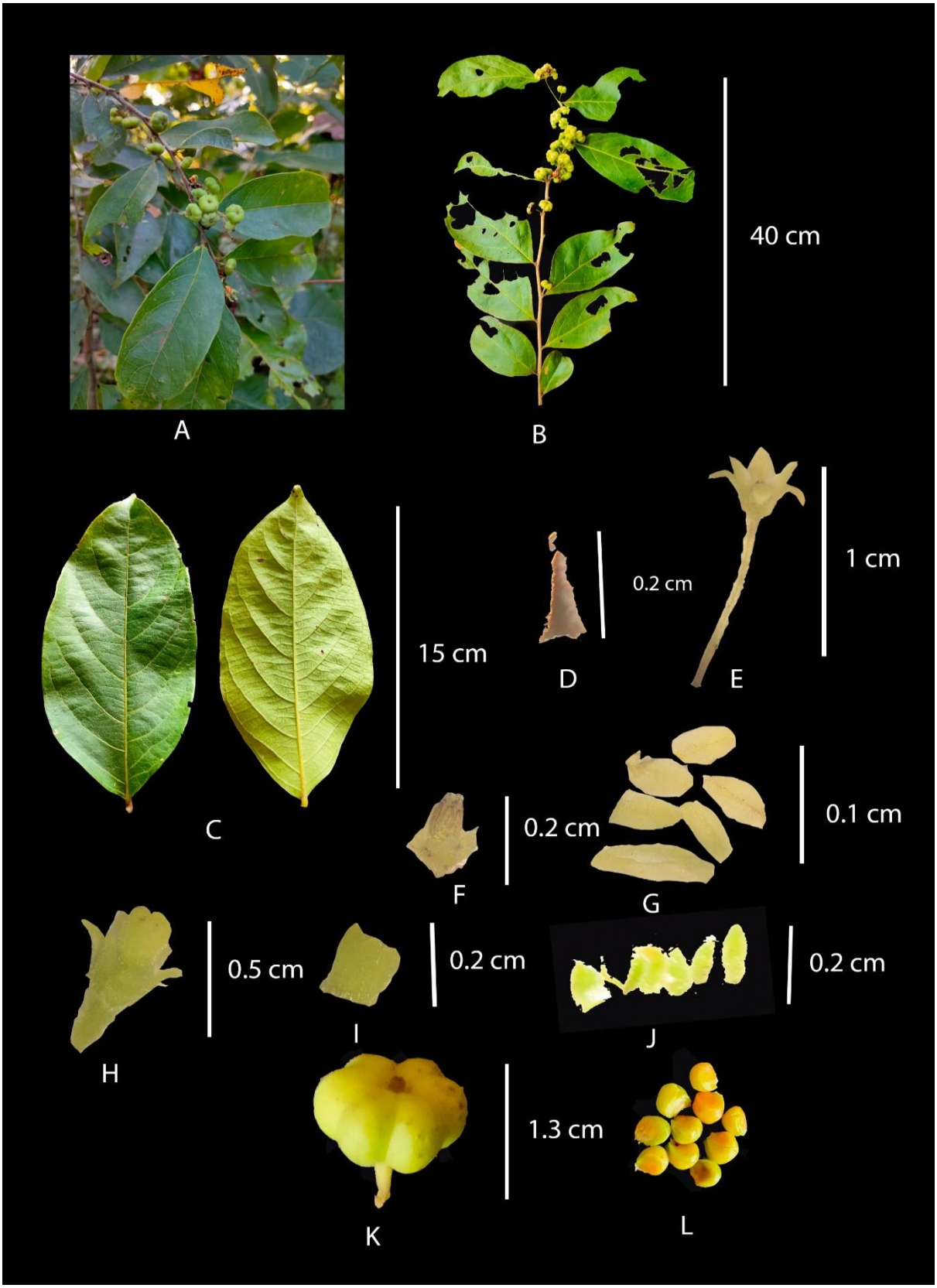

Plate 2. ***Glochidion heyneanum*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** A male flower; **F.** Anther; **G.** Sepals; **H.** A female flower; **I.** Style; **J.** Sepals; **K.** A capsule; **L.** Seeds.

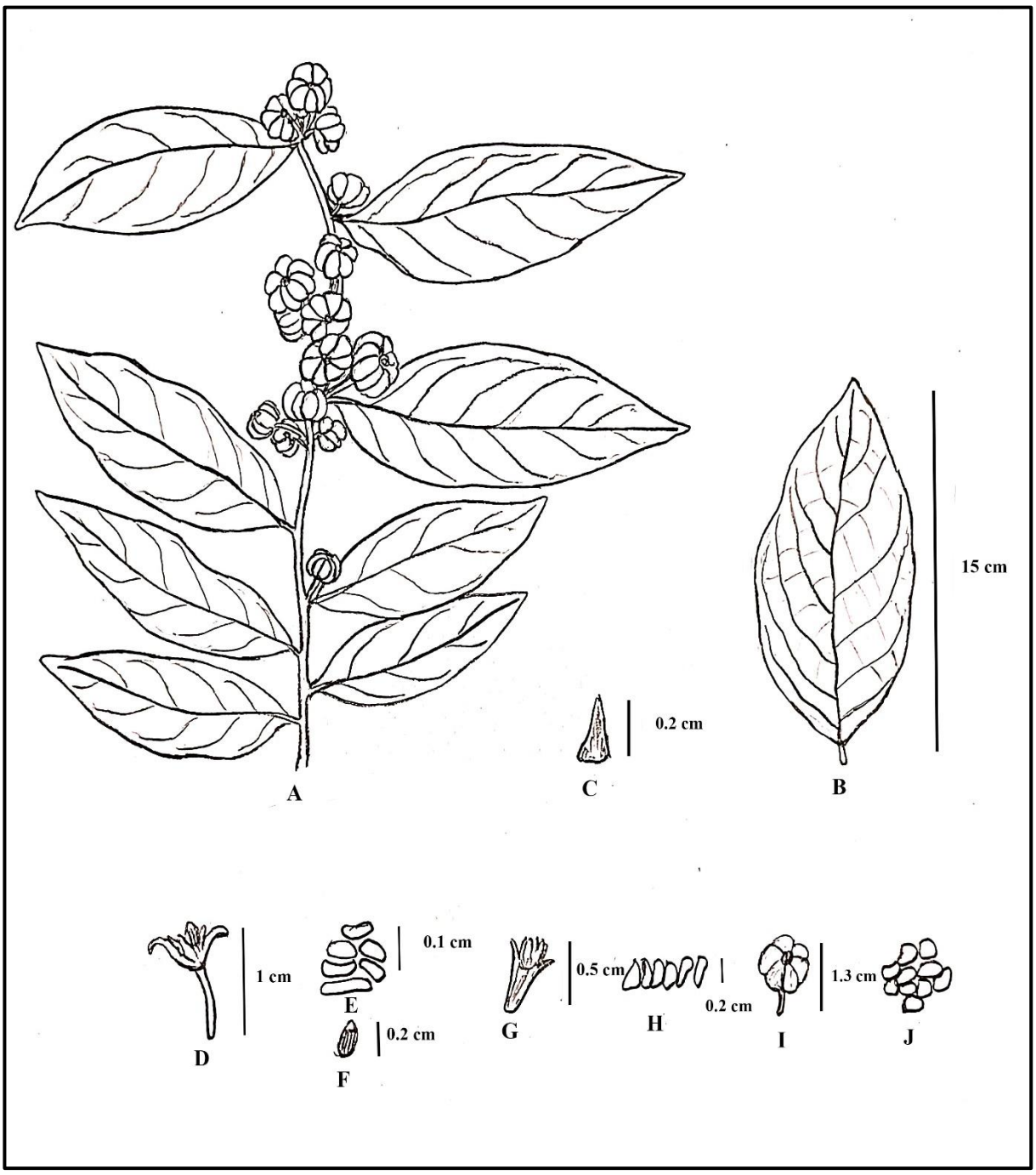

Figure 3. ***Glochidion heyneanum*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

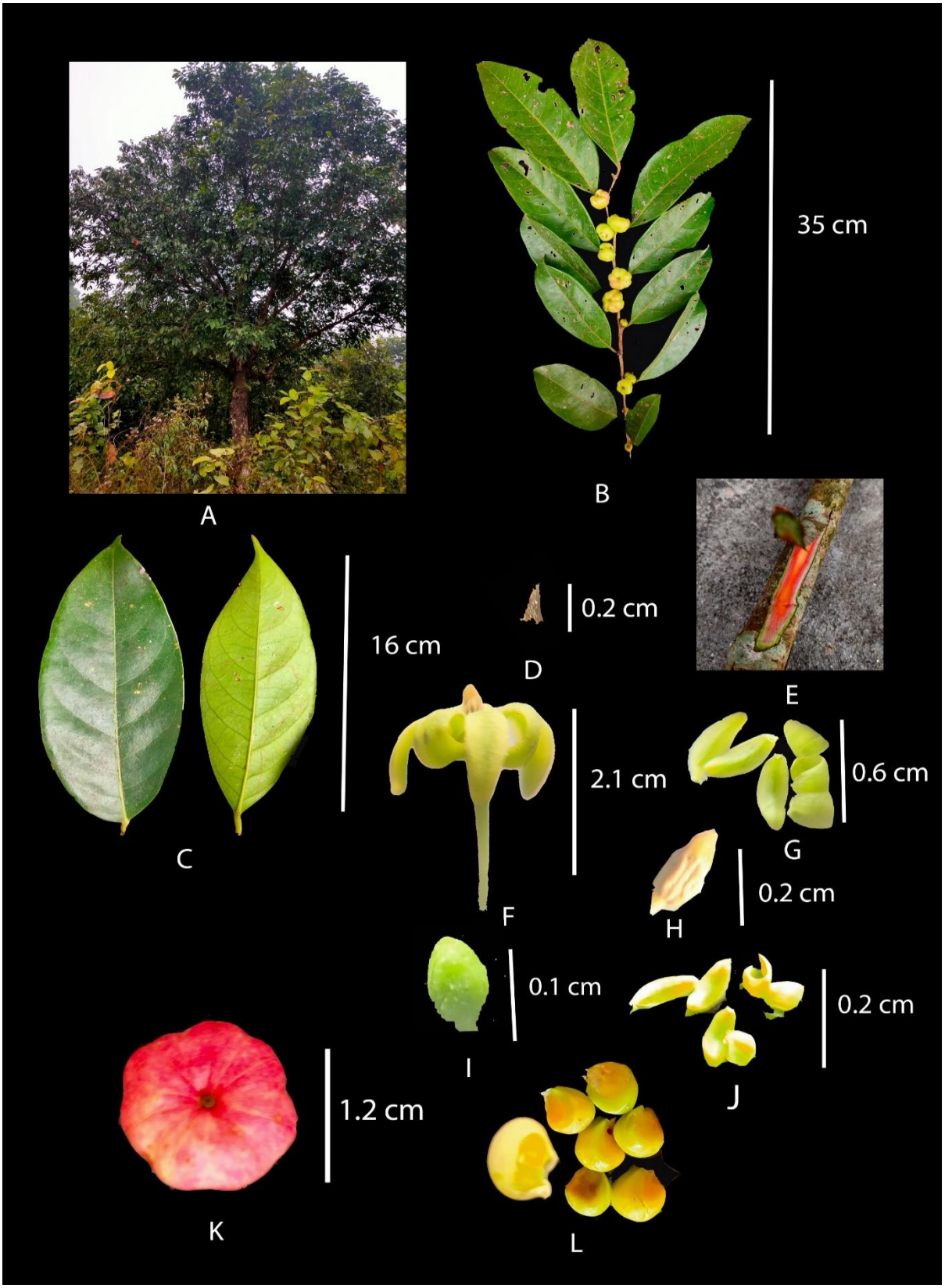

Plate 3. ***Glochidion lanceolarium*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** Bark of stem branch; **F.** A male flower; **G.** Sepals; **H.** Anther; **I.** A female flower; **J.** Sepals; **K.** A capsule; **L.** Seeds.

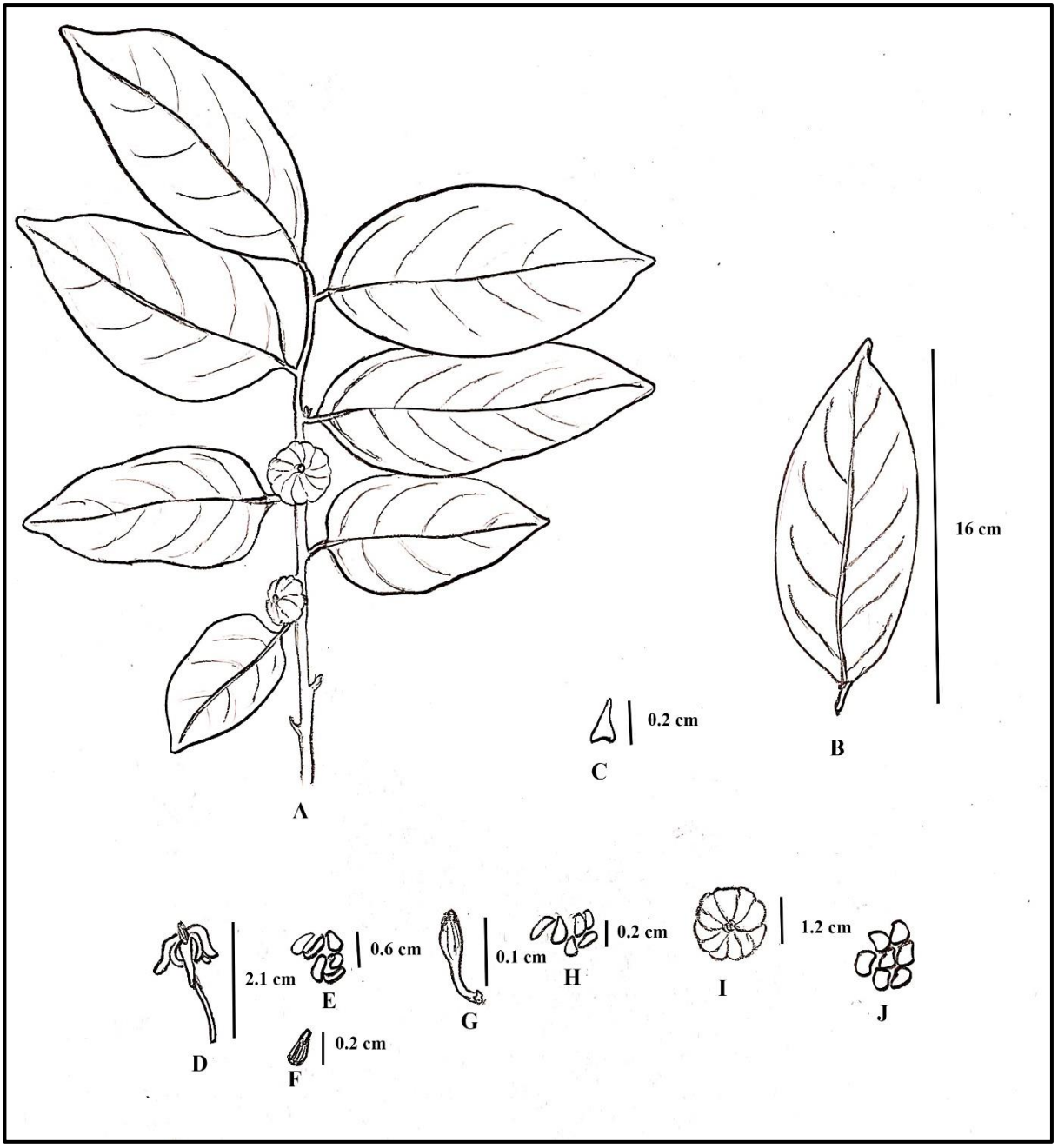

Figure 4. ***Glochidion lanceolarium*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

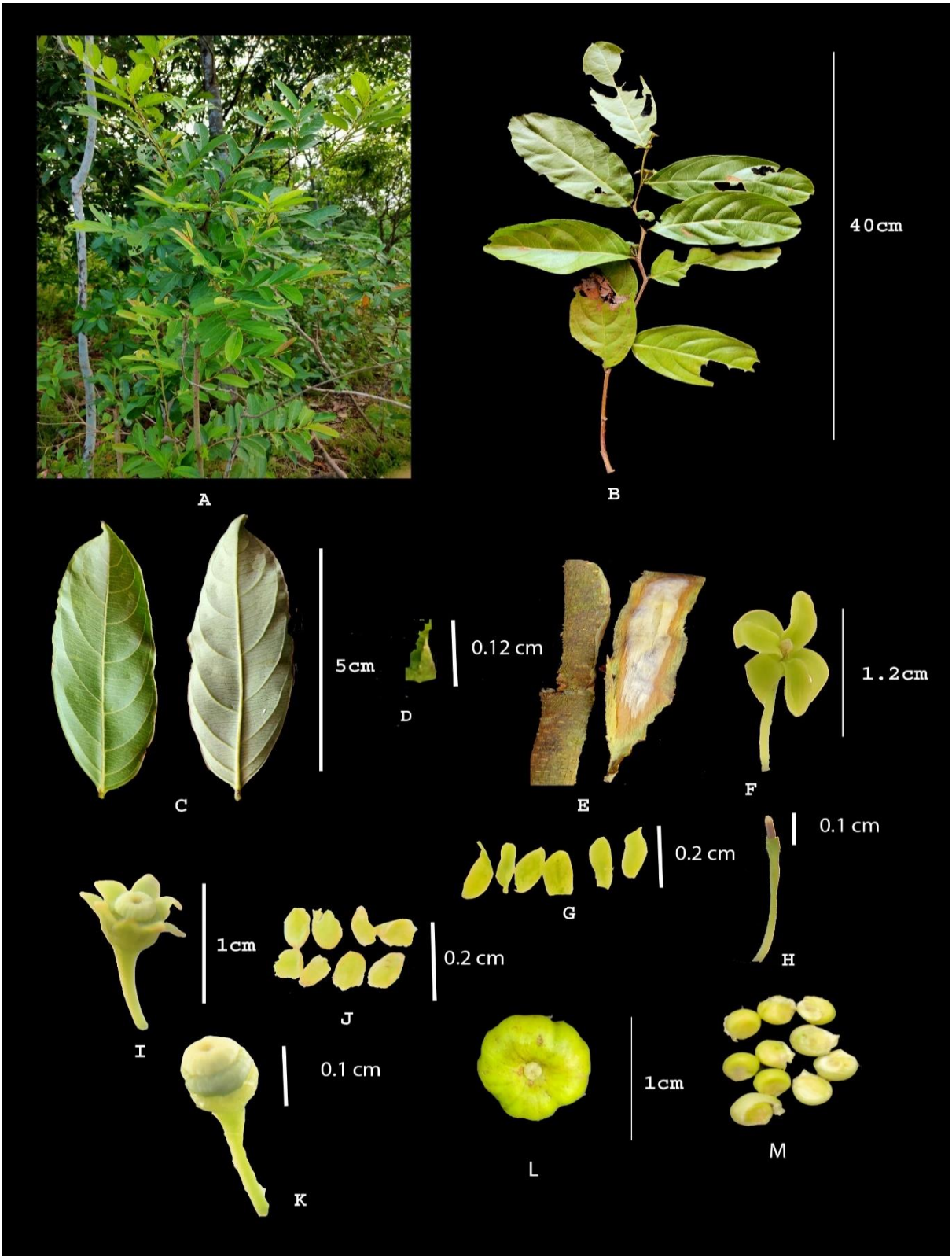

Plate 4. ***Glochidion multiloculare*** var. ***multiloculare*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** Bark of stem branch; **F.** A male flower; **G.** Sepals; **H.** Anther; **I.** A female flower; **J.** Sepals; **K.** Gynoecium; **L.** A capsule; **M.** Seeds.

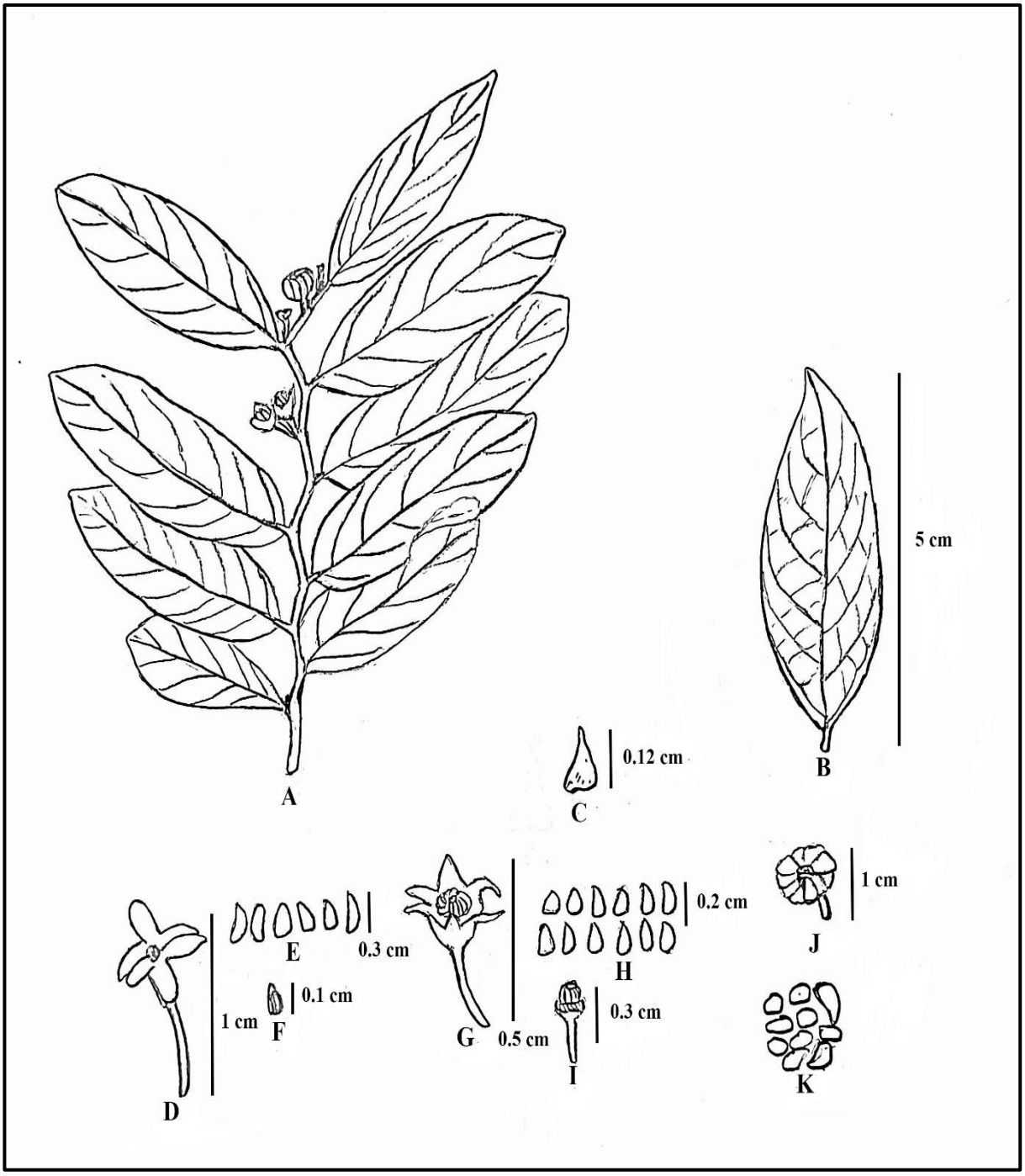

Figure 5. ***Glochidion multiloculare*** var. ***multiloculare*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** Gynoecium; **J.** A capsule; **K.** Seeds.

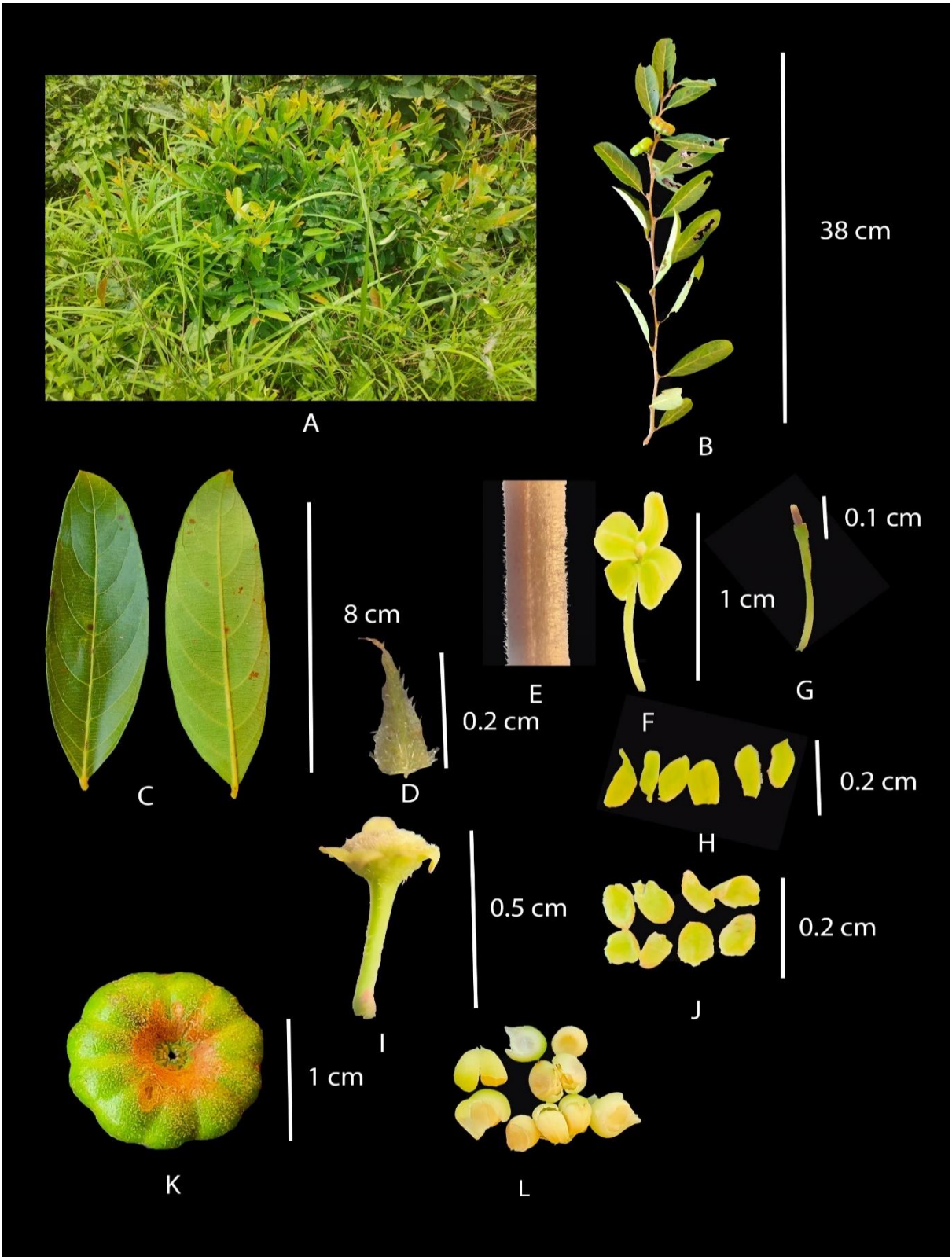

Plate 5. ***Glochidion multiloculare*** var. ***pubescens*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** Bark of stem branch; **F.** A male flower; **G.** Anther with pedicel; **H.** Sepals; **I.** A female flower; **J.** Sepals; **K.** A capsule; **L.** Seeds.

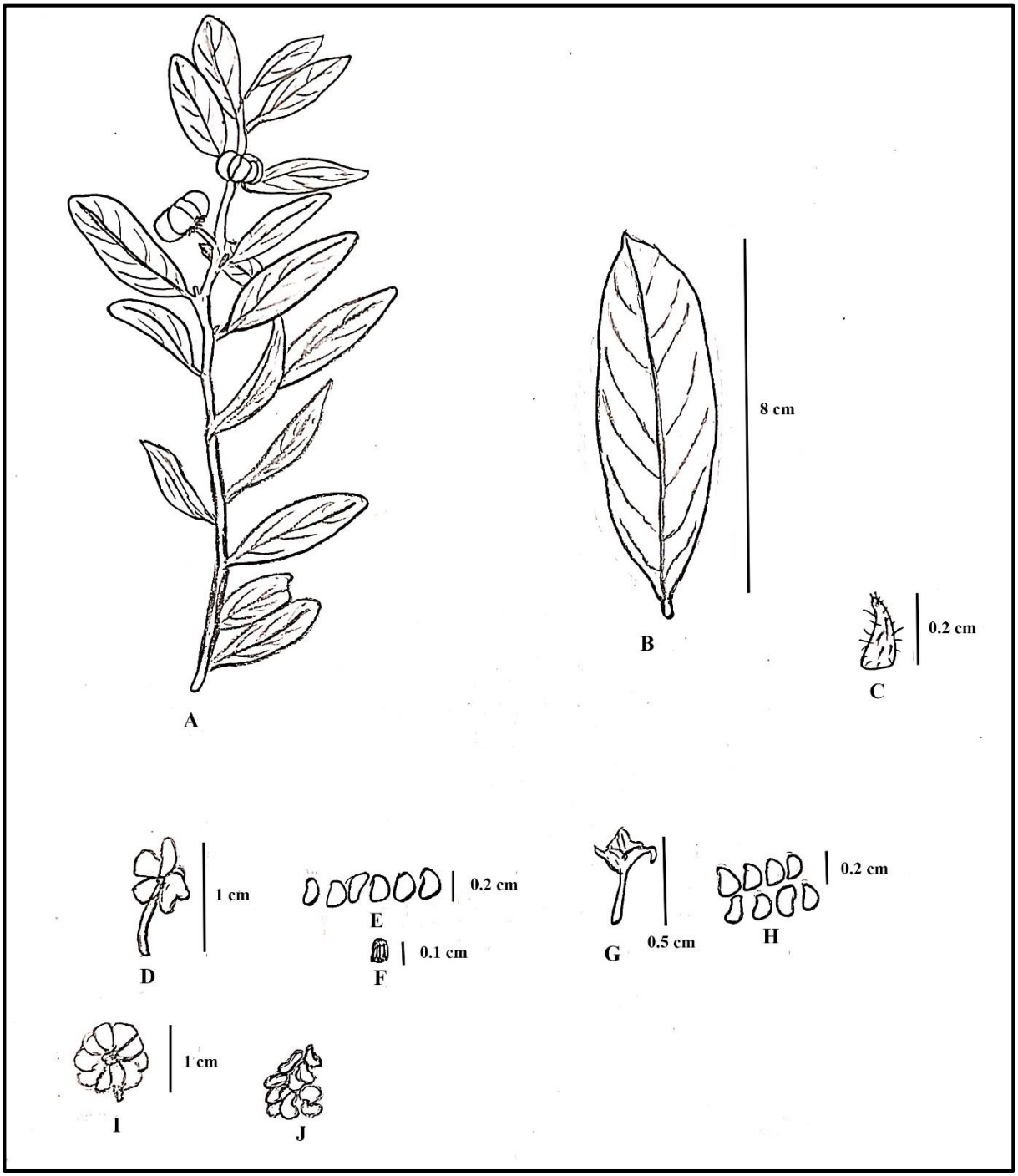

Figure 6. ***Glochidion multiloculare*** var. ***pubescens*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

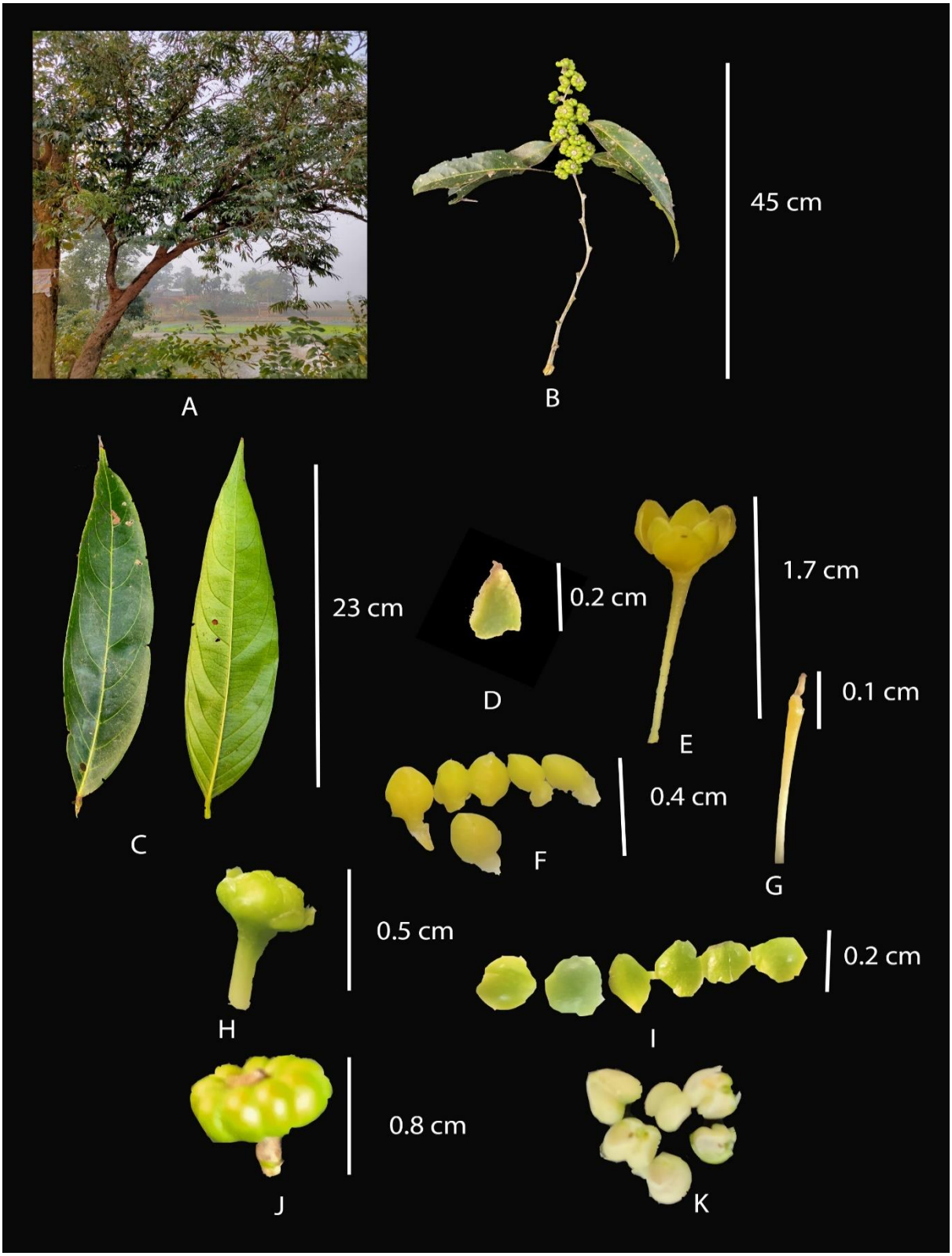

Plate 6. ***Glochidion sphaerogynum*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** A male flower; **F.** Sepals; **G.** Anther with pedicel; **H.** A female flower; **I.** Sepals; **J.** A capsule; **K.** Seeds.

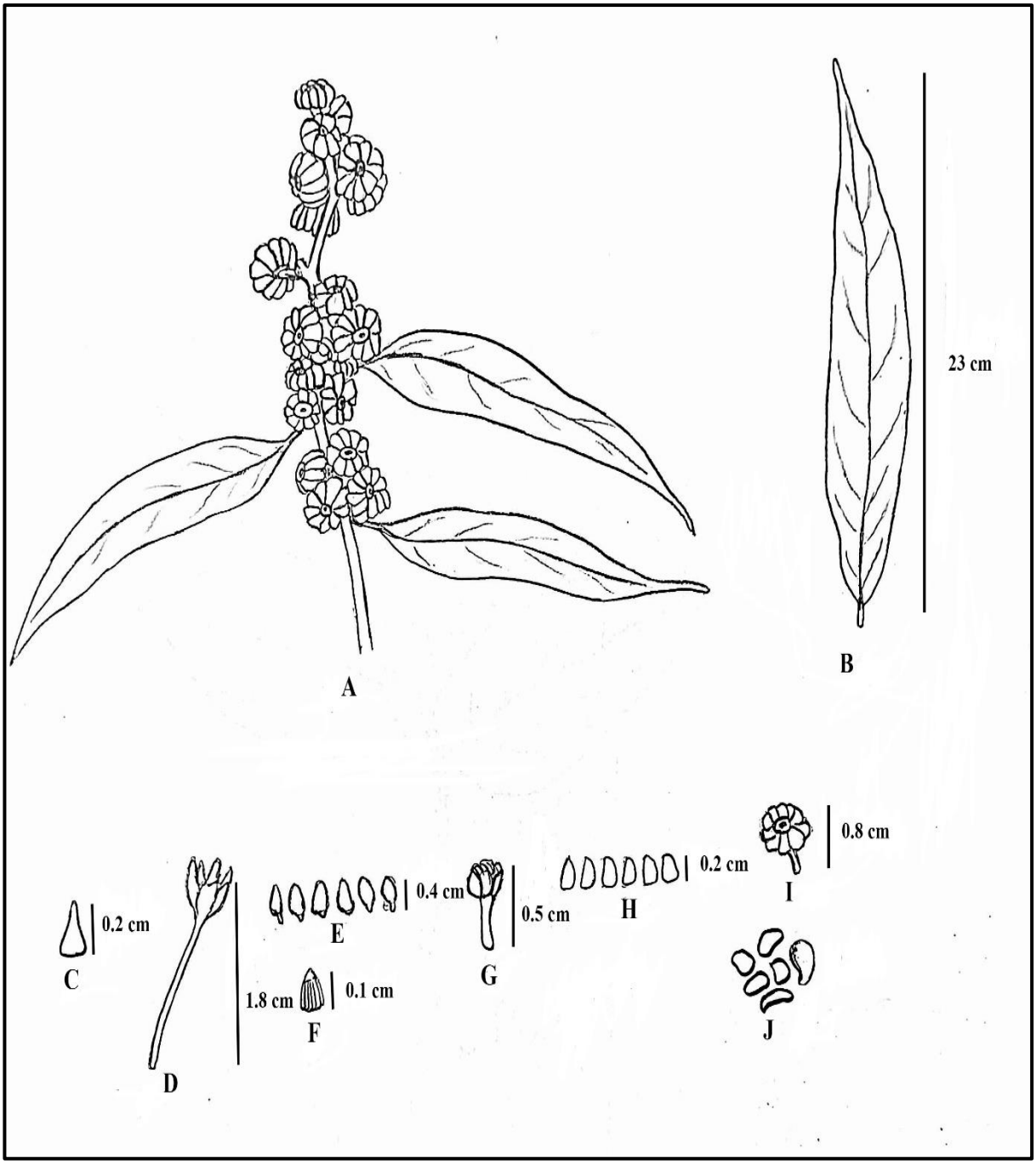

Figure 7. ***Glochidion sphaerogynum*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

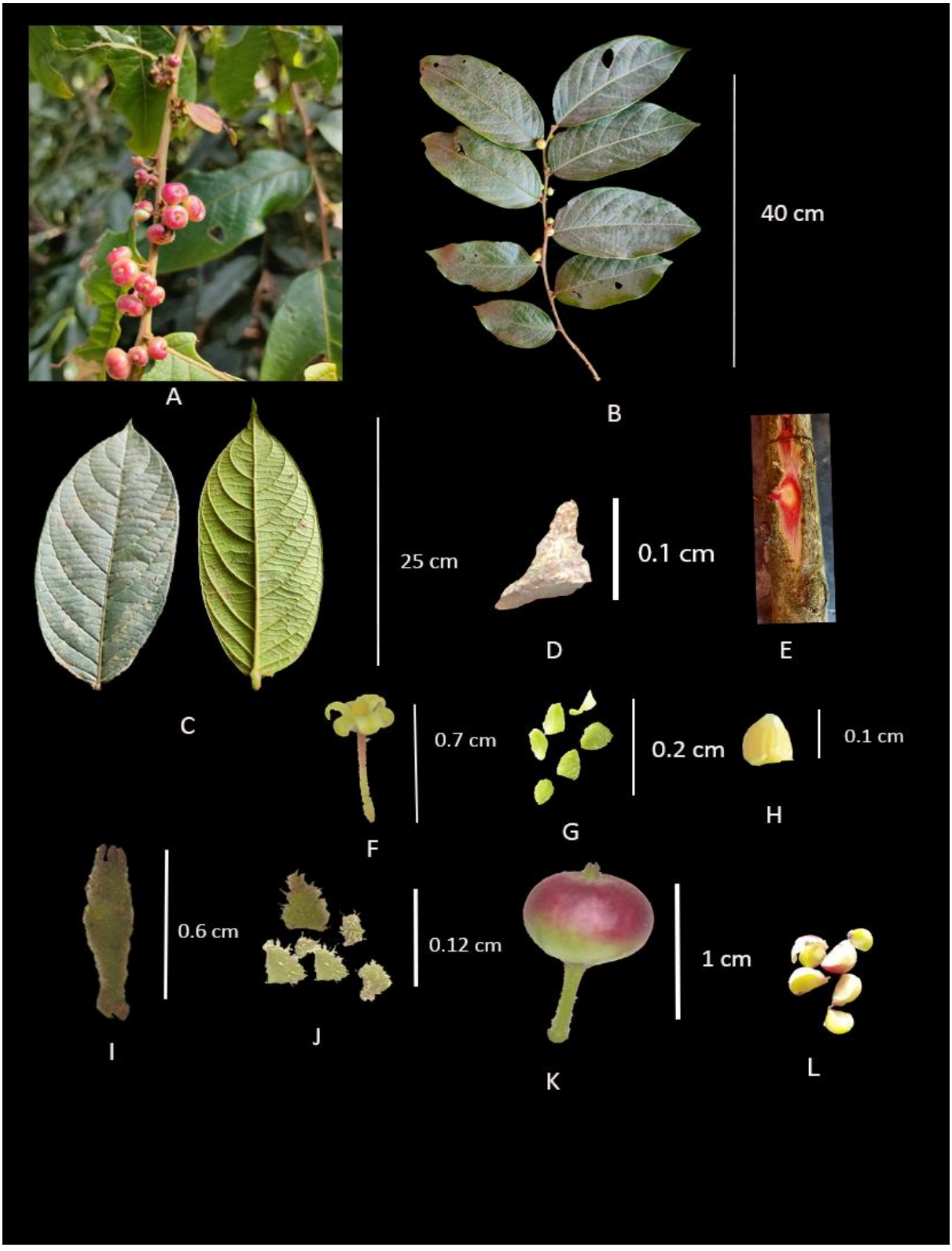

Plate 7. ***Glochidion zeylanicum*** var. ***arborescens*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** Bark of stem branch; **F.** A male flower; **G.** Sepals; **H.** Anther; **I.** A female flower; **J.** Sepals; **K.** A capsule; **L.** Seeds.

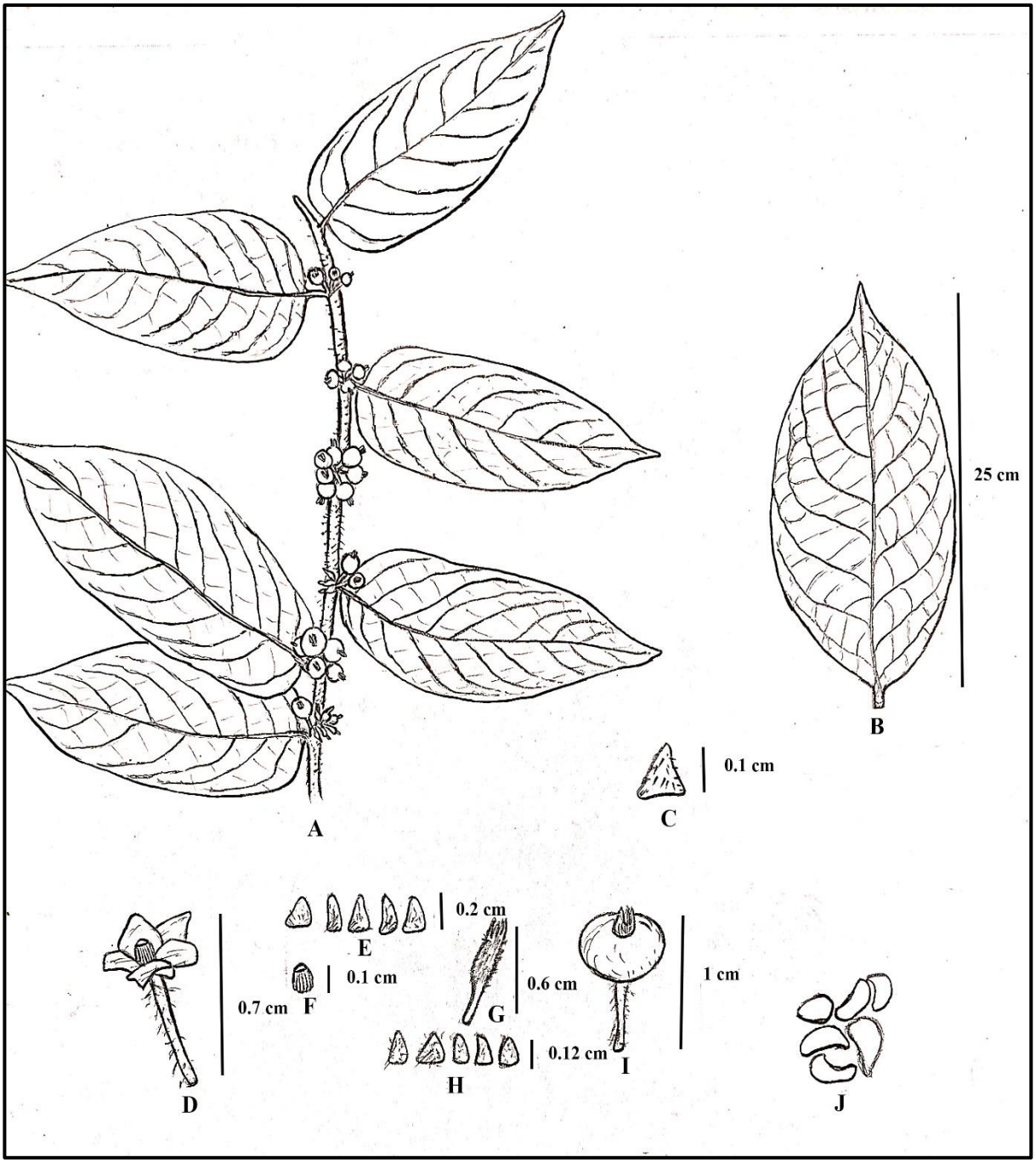

Figure 8. ***Glochidion zeylanicum*** var. ***arborescens*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

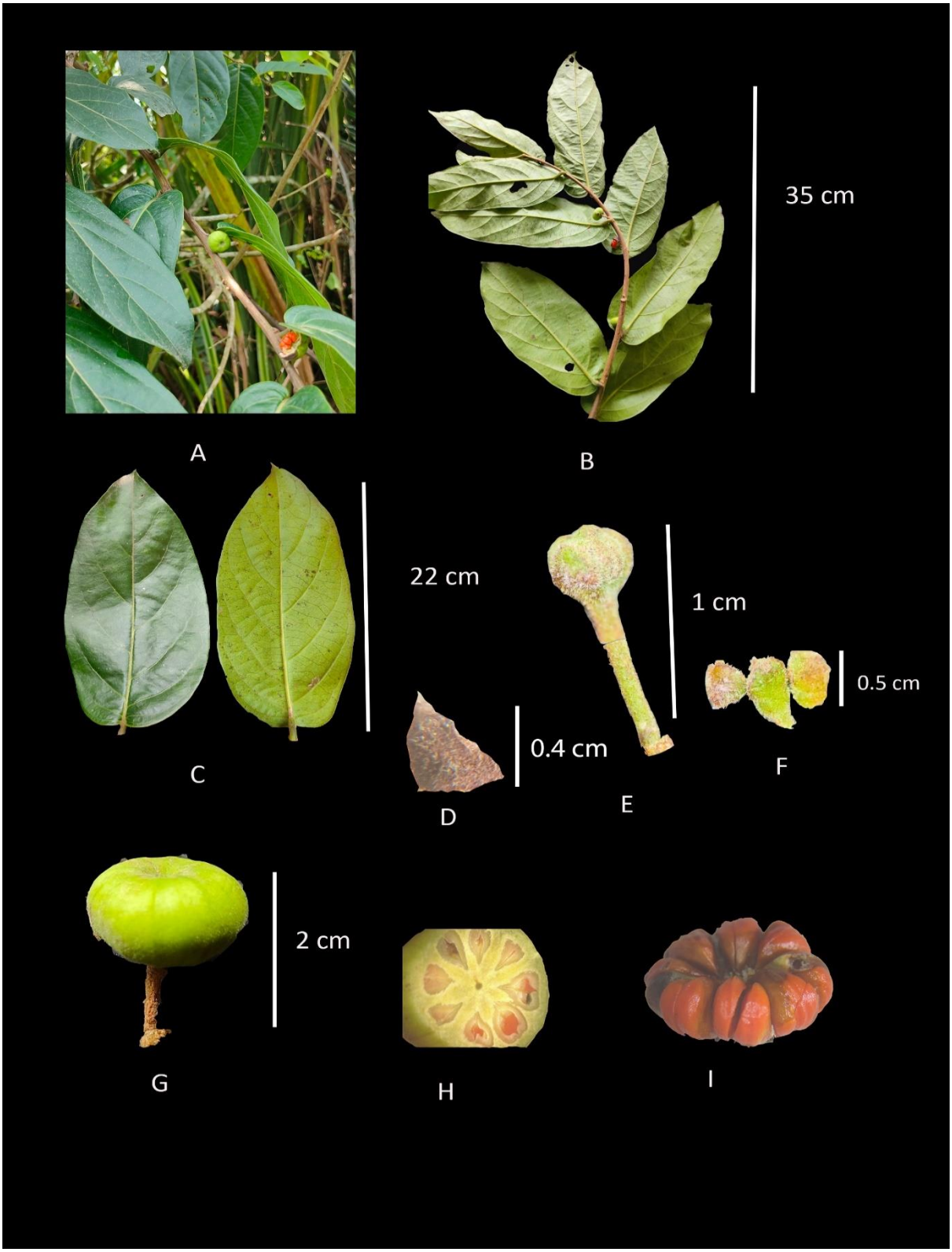

Plate 8. ***Glochidion zeylanicum*** var. ***paucicarpum*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** A female flower; **F.** Sepals; **G.** A capsule; **H.** LS view of capsule; **I.** Seeds.

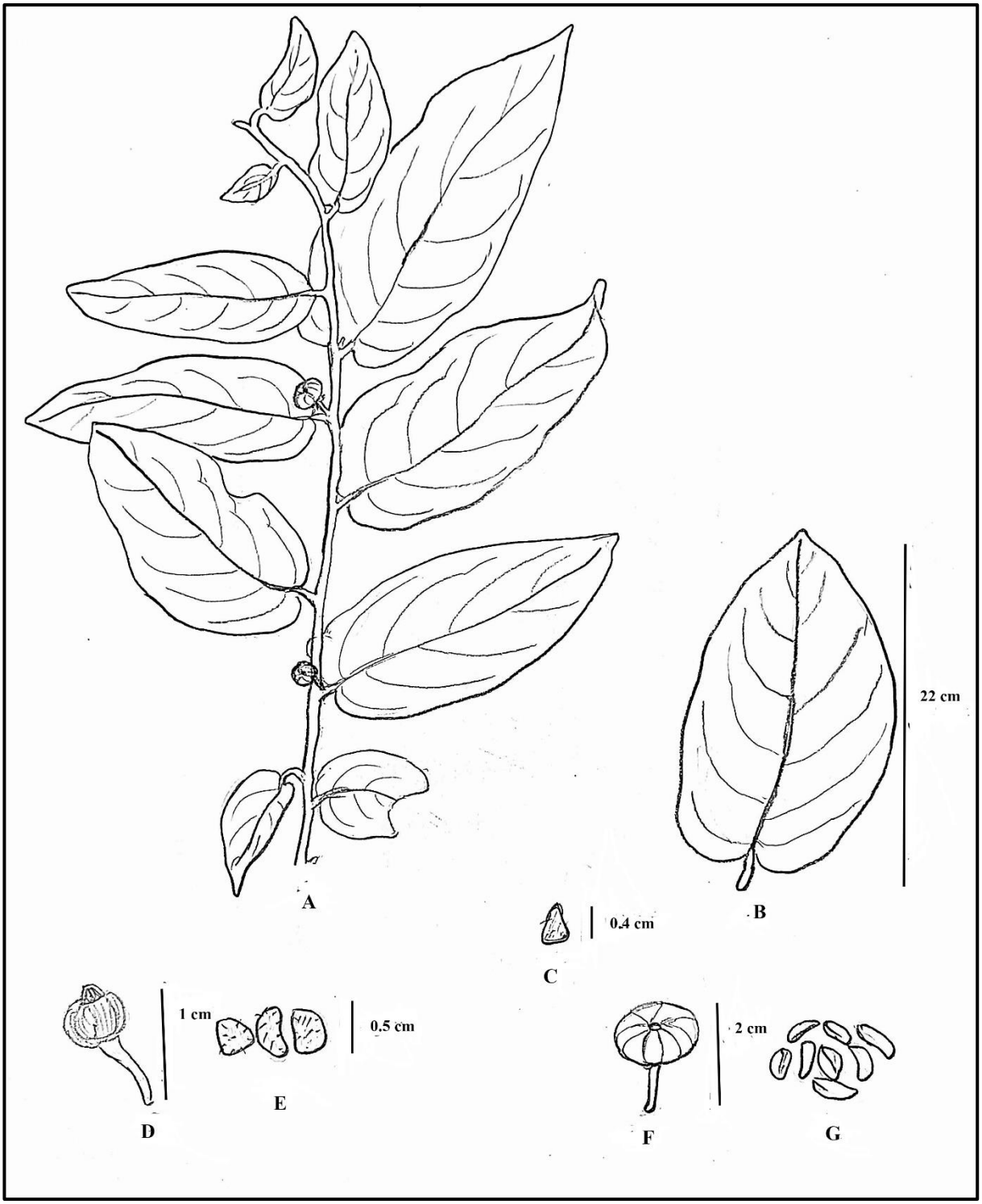

Figure 9. ***Glochidion zeylanicum*** var. ***paucicarpum*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A female flower; **E.** Sepals; **F.** A capsule; **G.** Seeds.

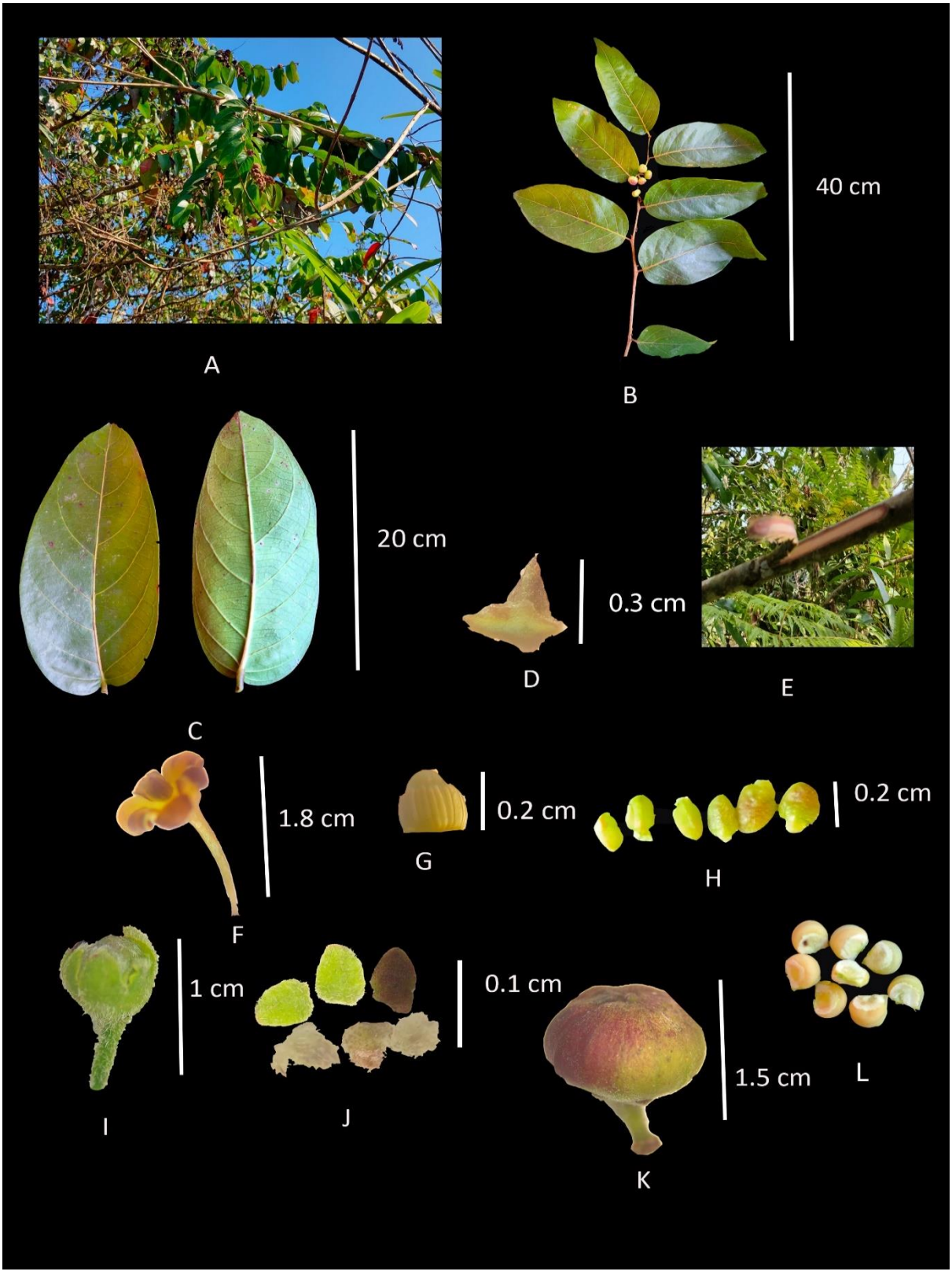

Plate 9. *Glochidion zeylanicum* var. ***tomentosum*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** Bark of stem branch; **F.** A male flower; **G.** Anther; **H.** Sepals; **I.** A female flower; **J.** Sepals; **K.** A capsule; **L.** Seeds.

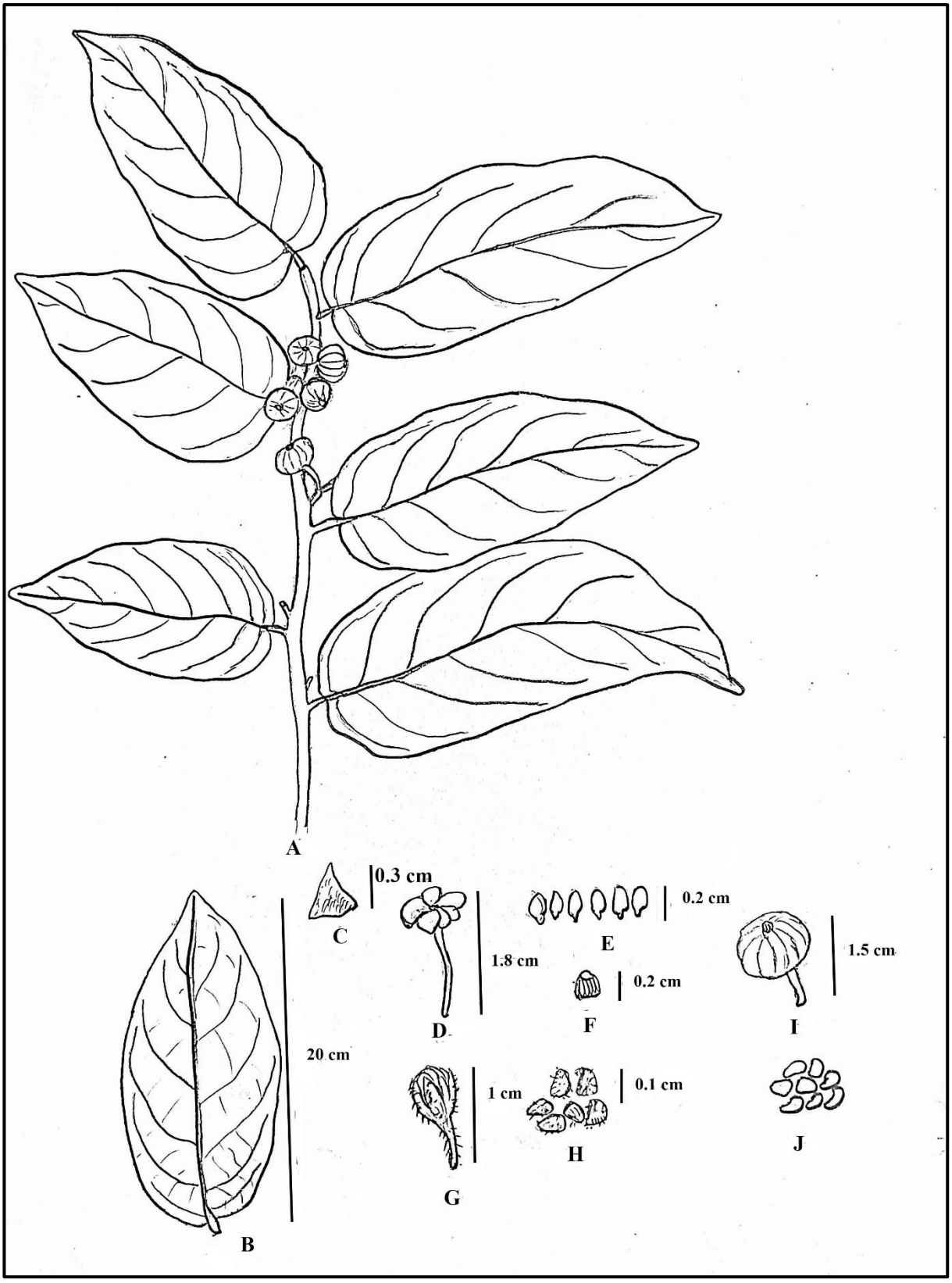

Figure 10. ***Glochidion zeylanicum*** var. ***tomentosum*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

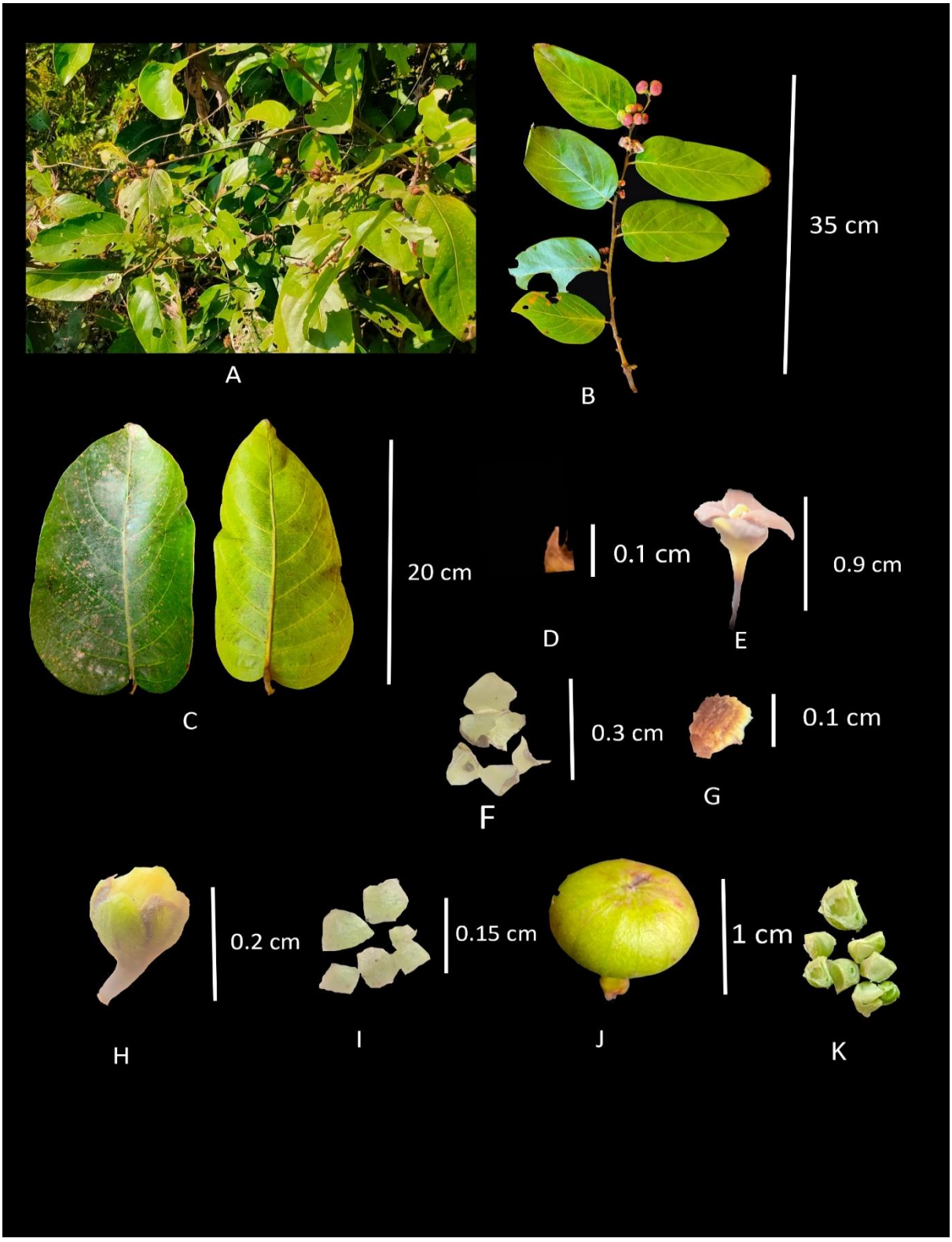

Plate 10. ***Glochidion zeylanicum*** var. ***zeylanicum*** **A.** Habit; **B.** A reproductive twig; **C.** Adaxial and Abaxial surface of leaves; **D.** A stipule; **E.** A male flower; **F.** Sepals; **G.** Anther; **H.** A female flower; **I.** Sepals; **J.** A capsule; **K.** Seeds.

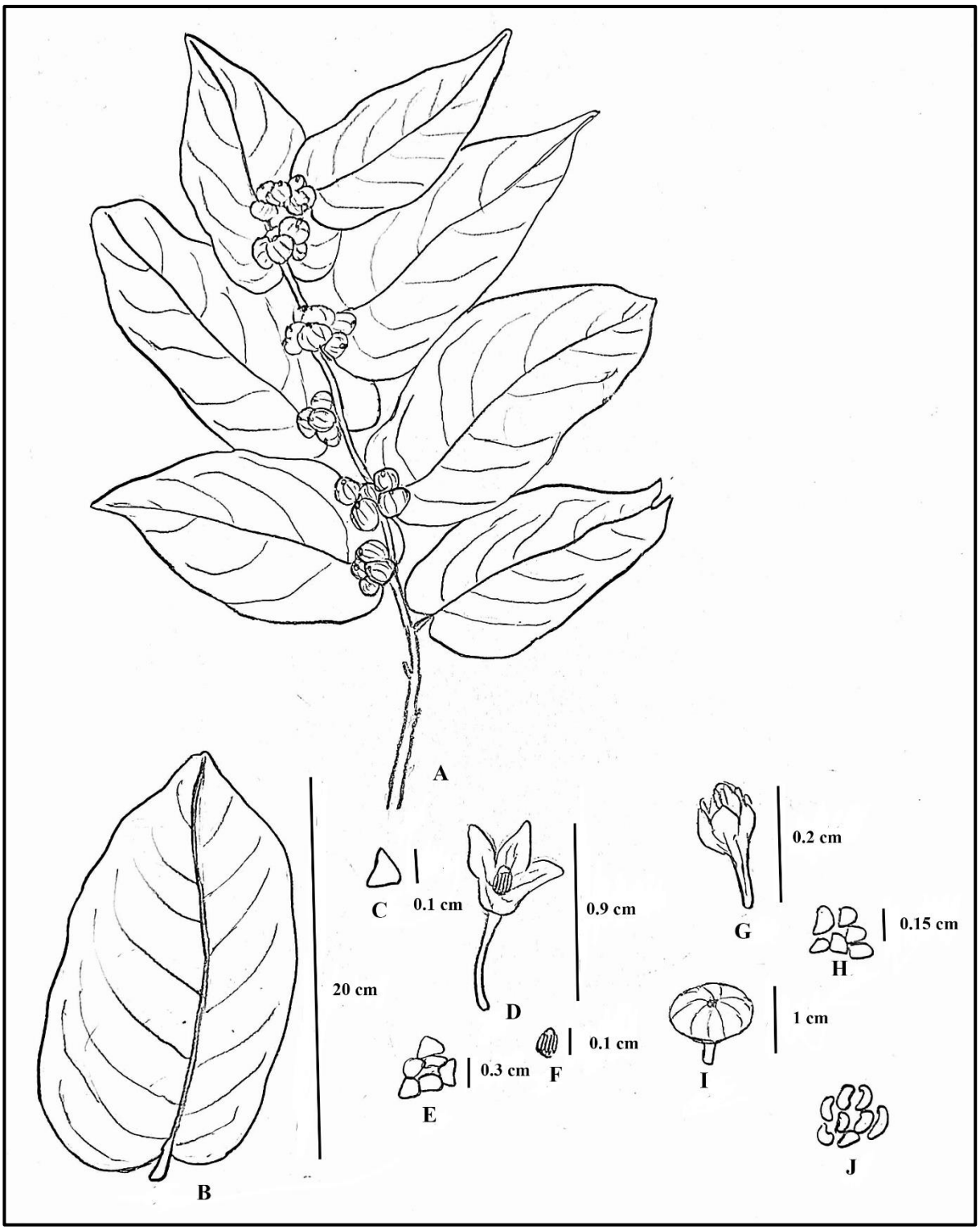

Figure 11. ***Glochidion zeylanicum*** var. ***zeylanicum*** (Illustration) **A.** A reproductive twig; **B.** A single leaf; **C.** A stipule; **D.** A male flower; **E.** Sepals; **F.** Anther; **G.** A female flower; **H.** Sepals; **I.** A capsule; **J.** Seeds.

4.3. Foliar epidermal study

4.3.1. Key to the species and varieties

1a. Leaves amphistomatic……...**2**

1b. Leaves hypostomatic…….**4**

2a. Both epicuticular wax crystals and papillae are

present around stomata on abaxial side…….**3**

2b. Only epicuticular wax crystals slightly present

around stomata on abaxial side……..**6. *G. sphaerogynum***

3a. Stomata are anomocytic, anisocytic, hemiparacytic in

the abaxial surface and anomocytic, anisocytic

in the adaxial surface…….**4. *G. multiloculare*** var. ***multiloculare***

3b. Stomata are anomocytic, anisocytic, paracytic

in the abaxial surface and anomocytic and

anisocytic in the adaxial surface…….……**5. *G. multiloculare*** var. ***pubescens***

4a. Druse and prismatic crystals are present

on the adaxial surface…….**1. *G. ellipticum***

4b. Druse and prismatic crystals are absent……,,……....**5**

5a. Epidermal cell shapes are isodiametric, pentagonal,

hexagonal to polygonal on both surface of the leaf.....**2. *G. heyneanum***

5b. Epidermal cell shapes are undulated and

jigsaw on both surface of the leaf.....**3. *G. lanceolarium***

6a. Trichomes are absent on both abaxial

and adaxial surfaces……..**10. *G. zeylanicum*** var. ***zeylanicum***

6b. Trichomes are present on both abaxial

and adaxial surfaces…….**7**

7a. Peltate trichomes present on both abaxial

and adaxial surface……**8. *G. zeylanicum*** var. ***paucicarpum***

7b. Peltate trichomes absent on both abaxial and adaxial surface……**8**

8a. Trichome length varies from 195.033±1.374 µm

on the abaxial surface to 151.023±1.450 µm

on the adaxial surface……**7. *G. zeylanicum*** var. ***arborescens***

8b. Trichome length varies from 176.486±2.977 µm
on the abaxial surface to 115.196±1.205 µm
on the adaxial surface……**9. *G. zeylanicum*** var. ***tomentosum***

1. *Glochidion ellipticum* Wight

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is anomocytic, anisocytic, and paracytic on the abaxial surface. The shape of the stomata is elliptic to oval shape. The number of stomata per area is 67–79 and the density is 72.667±1.027. Epidermal cell density is 229.33±1.527. The length of the stomata is 43.14±2.340 µm and the width is 24.756±1.432 µm. The stomatal area is 838.156 μm^2. Stomatal index is 24.06 %. Epidermal cell shapes are jigsaw, and rectangular. The anticlinal cell wall is sinuous on the abaxial surface. Druse and prismatic crystals were present on the adaxial surface and absent on the abaxial surface. Trichomes are also absent on both surfaces of the leaf. On the adaxial surface, stomata are absent. Epidermal cell shapes are jigsaw, and rectangular and the anticlinal cell wall is sinuous on the adaxial surface. **(Plate 11)**

2. *Glochidion heyneanum* (Wight & Arn.) Wight

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is anomocytic and anisocytic on the abaxial surface. The Stomatal shape is elongated. The number of stomata per area is 110–156 and the density is 133.333±2.007. Epidermal cell density is 718±1.502. The length of the stomata is 24.336±0.293 µm and the width is 12.99±1.535 µm. The stomatal area is 248.096 μm^2. Stomatal index is 15.66 %. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is sinuous, rounded, smooth, and angular on the abaxial surface. Papillae and epicuticular wax crystals are absent on both the abaxial and adaxial surfaces. Trichomes occur on both surfaces of the leaf. Uncinate, hooked, multicellular, unbranched, non-glandular types of trichomes have been observed on the abaxial surface. The length of the trichome is 144.473±1.618 µm. On the adaxial surface, stomata are absent. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is sinuous, rounded, smooth, and angular on the adaxial surface. Trichomes are uncinate, hooked, multicellular, unbranched, non-glandular types. The length of the trichome is 114.033±1.881 µm. **(Plate 12)**

3. *Glochidion lanceolarium* (Roxb.) Voigt

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is anomocytic, anisocytic, and hemiparacytic on the abaxial surface. The shape of the stomata is elongated. The number of stomata per area is 62–90 and the density is 77±1.106. Epidermal cell density is 278.333±2.052. The length of the stomata is 25.843±2.437 µm and the width is 18.01±2.78 µm. The stomatal area is 365.322 μm^2. Stomatal index is 21.66 %. Epidermal cell shapes are undulated and jigsaw. The anticlinal cell wall is sinuous. Papillae and epicuticular wax crystals are absent on both the abaxial and adaxial surfaces. Trichomes are also absent on both surfaces of the leaf. On the adaxial surface, stomata are absent. Epidermal cell shapes are undulated and jigsaw. The anticlinal cell wall is sinuous. **(Plate 13)**

4. *Glochidion multiloculare* (Rottler ex Willd.) Voigt var. ***multiloculare***

Leaves are amphistomatic. Stomata are randomly present on both abaxial and adaxial surfaces of the leaf and the number of stomata on the abaxial surface is higher than on the adaxial surface. The stomatal type is anomocytic and anisocytic. The shape of the stomata is elongated to elliptic. The number of stomata per area is 13–16 and the density is

14.333±1.527. Epidermal cell density is 109.33±1.503. The length of the stomata is 35.81±2.506 µm and the width is 21.016±1.651 µm. Stomatal area is 590.608 μm^2. Stomatal index is 11.56 %. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is smooth, angular, rounded, and irregularly thickened. Papillae and epicuticular wax crystals are present on the abaxial surface. Papillae are rounded and epicuticular wax crystals are thick waxes at the papillae, smooth, and upright around the stomata. Trichomes are absent. On the adaxial surface, stomata are anomocytic, and anisocytic types. The shape of the stomata is elongated to elliptic. The number of stomata per area is 7–11 and the stomatal density is 9.333±0.081. Epidermal cell density is 84.333±1.041. The length of the stomata is 33.46±2.180 µm and the width is 20.406±1.304 µm. Stomatal area is 535.828 μm^2. Stomatal index is 10.02 %. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is smooth, angular, rounded, and irregularly thickened. Papillae, epicuticular wax crystals, and trichomes are absent. **(Plate 14)**

5. *Glochidion multiloculare* var. ***pubescens*** Chakrab. & M.Gangop.

Leaves are amphistomatic. Stomata are randomly present on both surfaces of the leaf and stomatal number on the abaxial surface is higher than on the adaxial surface. The stomatal type is anomocytic, anisocytic, and paracytic on the abaxial surface. The stomatal shape is elliptic. The number of stomata per area is 14–18 and the density is 16.333±2.081. Epidermal cell density is 111.667±1.743. The length of the stomata is 34.15±1.047 µm and the width is 20.603±1.499 µm. The stomatal area is 552.239 μm^2. Stomatal index is 12.75 %. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is smooth, angular, and rounded. Papillae and epicuticular wax crystals are present on the abaxial surface. Papillae are rounded and epicuticular wax crystals are thick waxes at the papillae and trichome, smooth, and upright around the stomata. Trichomes are present and they are uniseriate, multicellular, unbranched, and non-glandular. The length of the trichome is 131.336±1.170 µm. On the adaxial surface, stomata are anomocytic, and anisocytic types. The shape of the stomata is elliptic. The number of stomata per area is 11–16 and the density is 13.333±2.214. Epidermal cell density is 107.667±1.248. The length of the stomata is 37.31±2.192 µm and the width is 20.867±1.979 µm. Stomatal area is 611.247 μm^2. Stomatal index is 11.07 %. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is smooth, angular, rounded, and irregularly thickened. Papillae and epicuticular wax

crystals are absent. Trichomes are uniseriate, multicellular, unbranched, and non-glandular types. The length of the trichome is 127.823±1.480 µm. **(Plate 15)**

6. *Glochidion sphaerogynum* (Mull.Arg.) Kurz

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is anomocytic and paracytic on the abaxial surface. Stomatal shape is elliptic. The number of stomata per area is 95–108 and the density is 101.333±1.506. Epidermal cell density is 438.667±1.509. The length of the stomata is 24.06±2.442 µm and the width is 9.696±2.850 µm. The stomatal area is 183.015 μm^2. Stomatal index is 18.77 %. Epidermal cell shapes are undulated and jigsaw. The anticlinal cell wall is sinuous. Papillae is slightly present around the stomata on the abaxial surface. Epicuticular wax crystals are slightly present on the abaxial surface and absent on adaxial surfaces. Trichomes are also absent on both surfaces of the leaf. On the adaxial surface, stomata are absent. Epidermal cell shapes are undulated and jigsaw. The anticlinal cell wall is sinuous. **(Plate 16)**

7. *Glochidion zeylanicum* var. ***arborescens*** (Blume) Chakrab. & M.Gangop.

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is anomocytic and paracytic on the abaxial surface. The shape of the stomata is elliptic. The number of stomata per area is 111–140 and the density is 124±1.730. Epidermal cell density is 270±2.221. The length of the stomata is 11.70±1.112 µm and the width is 6.21±0.504 µm. The stomatal area is 57.035 μm^2. Stomatal index is 31.47 %. Epidermal cell shapes are jigsaw, pentagonal, hexagonal to polygonal and undulated. The anticlinal cell wall is sinuous. Papillae and epicuticular wax crystals are absent on both the abaxial and adaxial surfaces. Trichomes are present on both surfaces of the leaf. Uniseriate, multicellular, unbranched, non-glandular types of trichomes have been observed on the abaxial surface. The length of the trichome is 195.033±1.374 µm. On the adaxial surface, stomata are absent. Epidermal cell shapes are jigsaw, pentagonal, hexagonal to polygonal and undulated. The anticlinal cell wall is sinuous. Trichomes are uniseriate, multicellular, unbranched, non-glandular types. The length of the trichome is 151.023±1.450 µm. **(Plate 17)**

8. *Glochidion zeylanicum* var. ***paucicarpum*** Chakrab. & N.P. Balakr.

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is paracytic, hemiparacytic on the abaxial surface. The shape of the stomata

is elliptic. The number of stomata per area is 104–128 and the density is 117±1.124. Epidermal cell density is 238±1.911. The length of the stomata is 20.026±1.706 µm and the width is 13.6±2.038 µm. The stomatal area is 213.733 μm^2. Stomatal index is 32.95 %. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is rounded, smooth, irregular, and slightly sinuous. Papillae and epicuticular wax crystals are absent on both the abaxial and adaxial surfaces. Trichomes are present on both surfaces of the leaf. Uniseriate, multicellular, unbranched, peltate, and non-glandular types of trichomes have been observed on the abaxial surface. The length of the trichome is 263.833±0.059 µm. On the adaxial surface, stomata are absent. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal. The anticlinal cell wall is rounded, smooth, irregular, and slightly sinuous. Trichomes are uniseriate, multicellular, unbranched, peltate, and non-glandular types. The length of the trichome is 244.513±1.085 µm. **(Plate 18)**

9. *Glochidion zeylanicum* var. ***tomentosum*** Trimen

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is anomocytic and anisocytic on the abaxial surface. The shape of the stomata is elliptic. The number of stomata per area is 80–92 and the density is 86.333±1.027. Epidermal cell density is 212.333±2.326. The length of the stomata is 14.367±0.529 µm and the width is 7.713±1.015 µm. The stomatal area is 86.972 μm^2. Stomatal index is 28.89 %. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal, jigsaw, and undulated. The anticlinal cell wall is rounded, smooth, irregular, and sinuous. Papillae and epicuticular wax crystals are absent on both the abaxial and adaxial surfaces. Trichomes are present on both surfaces of the leaf. Uniseriate, multicellular, unbranched, non-glandular types of trichomes have been observed on the abaxial surface. The length of the trichome is 176.486±2.977 µm. On the adaxial surface, stomata are absent. Epidermal cell shapes are isodiametric, pentagonal, hexagonal to polygonal, jigsaw, and undulated. The anticlinal cell wall is rounded, smooth, irregular, and sinuous. Trichomes are uniseriate, multicellular, unbranched, non-glandular types. The length of the trichome is 115.196±1.205 µm. **(Plate 19)**

10. *Glochidion zeylanicum* (Gaertn.) A.Juss. var. ***zeylanicum***

Leaves are hypostomatic. Stomata are present only on the abaxial surface of the leaf. The stomatal type is anomocytic, anisocytic, hemiparacytic, and paracytic on the abaxial

surface. The shape of the stomata is elliptic to oval type. The number of stomata per area is 80–100 and the density is 91.333±0.263. Epidermal cell density is 246±1.442. The length of the stomata is 17.507±1.847 µm and the width is 9.34±0.598 µm. The stomatal area is 128.308 μm^2. Stomatal index is 27.08 %. Epidermal cell shapes are jigsaw, pentagonal, hexagonal to polygonal, rectangular, and undulated. The anticlinal cell wall is sinuous and buttressed. Papillae and epicuticular wax crystals are absent on both the abaxial and adaxial surfaces. Trichomes are also absent on both surfaces of the leaf. On the adaxial surface, stomata are absent. Epidermal cell shapes are jigsaw, pentagonal, hexagonal to polygonal, rectangular, and undulated. The anticlinal cell wall is sinuous and buttressed. **(Plate 20)**

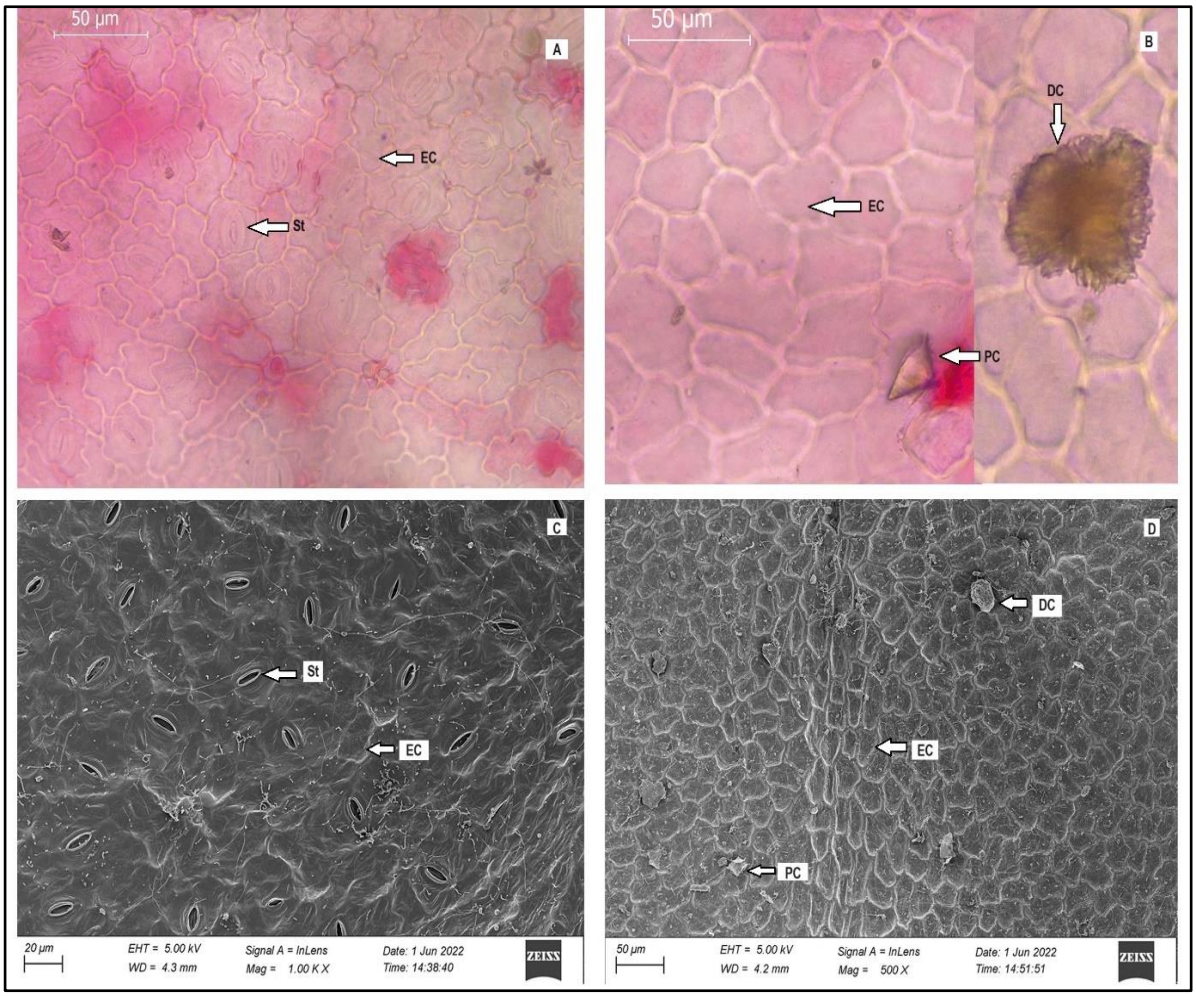

Plate 11. ***Glochidion ellipticum*** **A-B.** Light micrographs (LM) of abaxial and adaxial surface of foliar leaf epidermal features **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell, PC: Prismatic Crystal, DC: Druse Crystal. Scale bars = 50 µm (A, B, D), 20 µm (C).

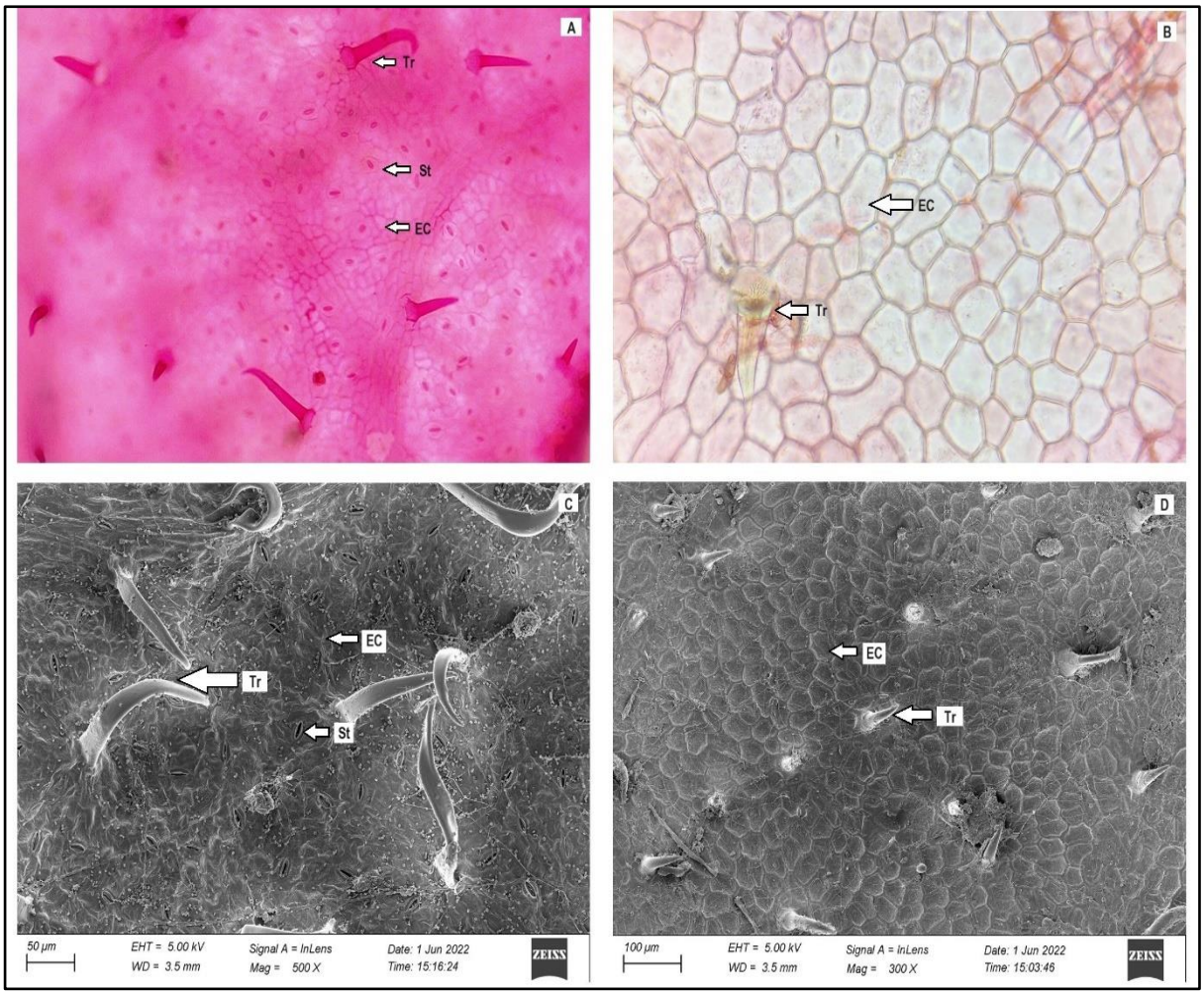

Plate 12. ***Glochidion heyneanum*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell, Tr: Trichome. Scale bars = 50 µm (A, B, C), 100 µm (D).

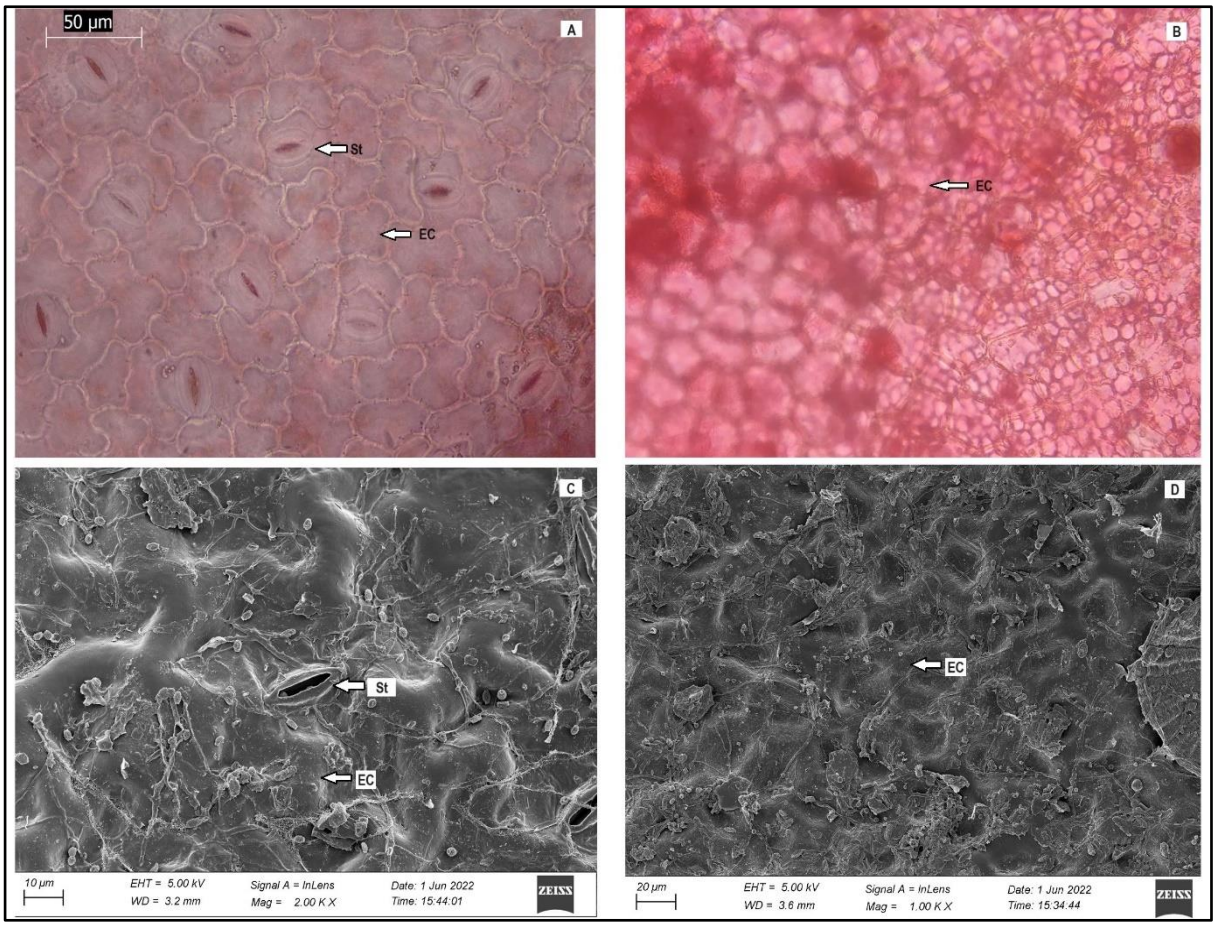

Plate 13. ***Glochidion lanceolarium*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell. Scale bars = 50 µm (A, B), 10 µm (C), 20 µm (D).

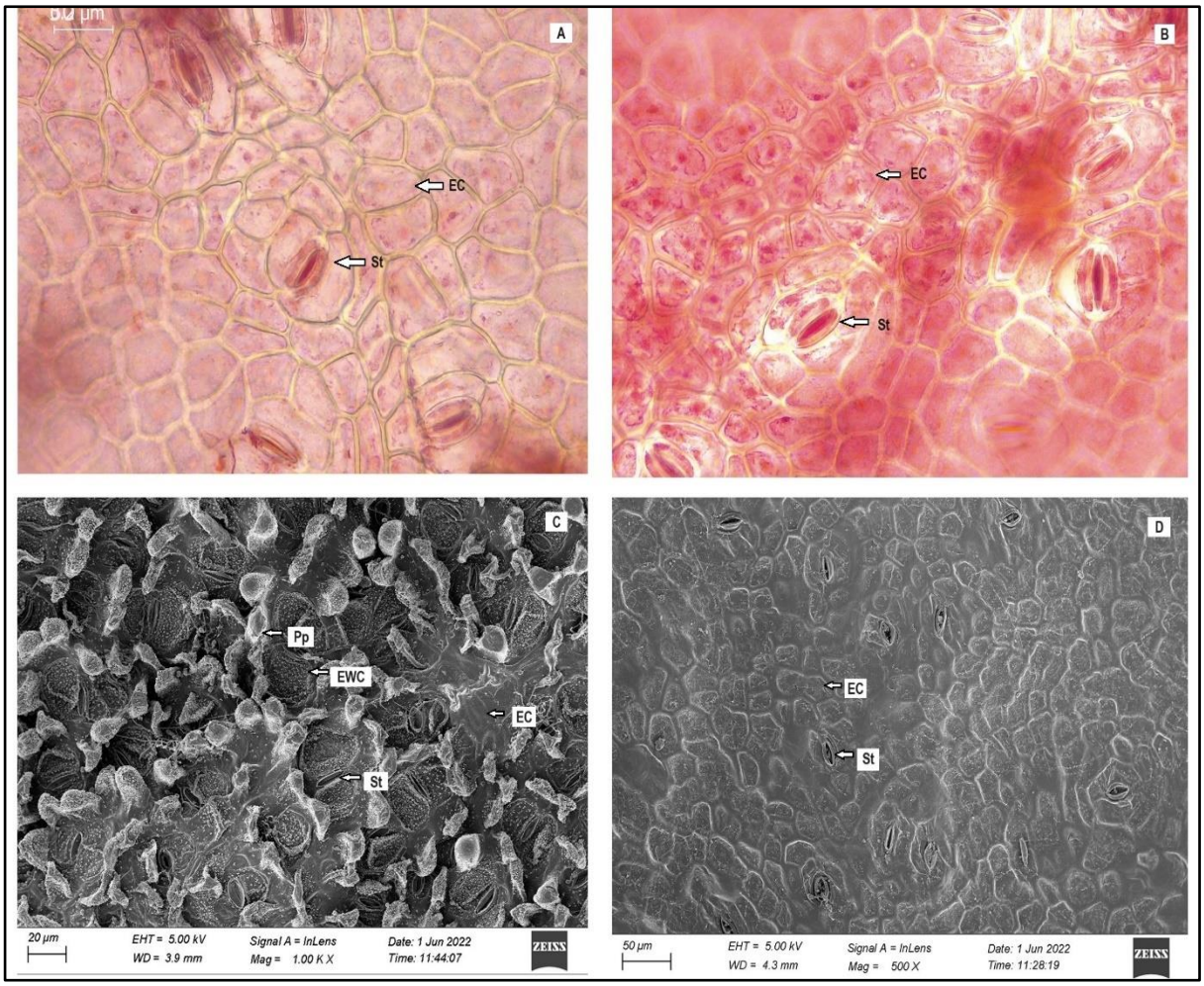

Plate 14. ***Glochidion multiloculare*** var. ***multiloculare*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell, EWC: Epicuticular Wax Crystal, Pp: Papillae. Scale bars = 50 µm (A, B, D), 20 µm (C).

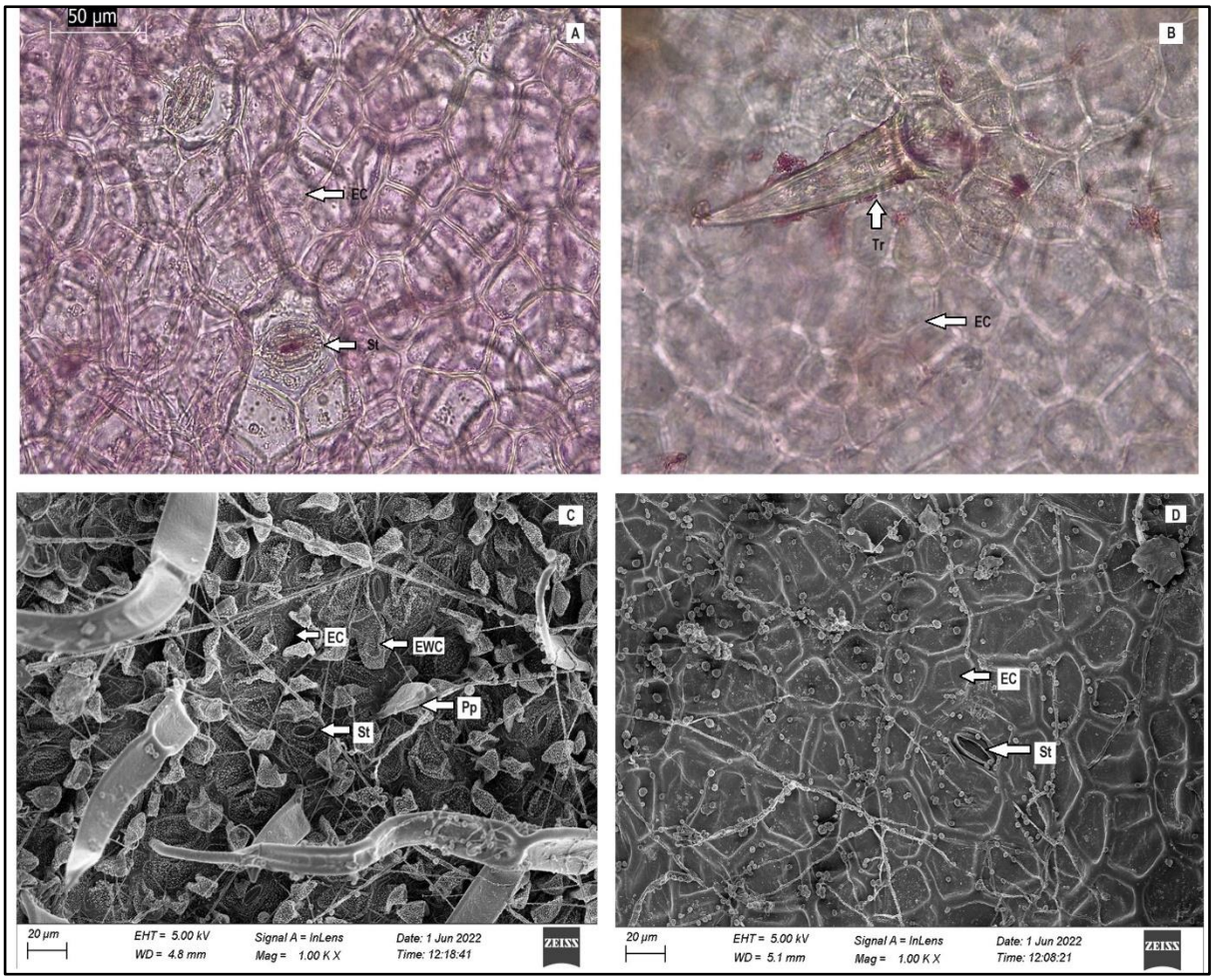

Plate 15. ***Glochidion multiloculare*** var. ***pubescens*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell, EWC: Epicuticular Wax Crystal, Pp: Papillae, Tr: Trichome. Scale bars = 50 µm (A, B), 20 µm (C, D).

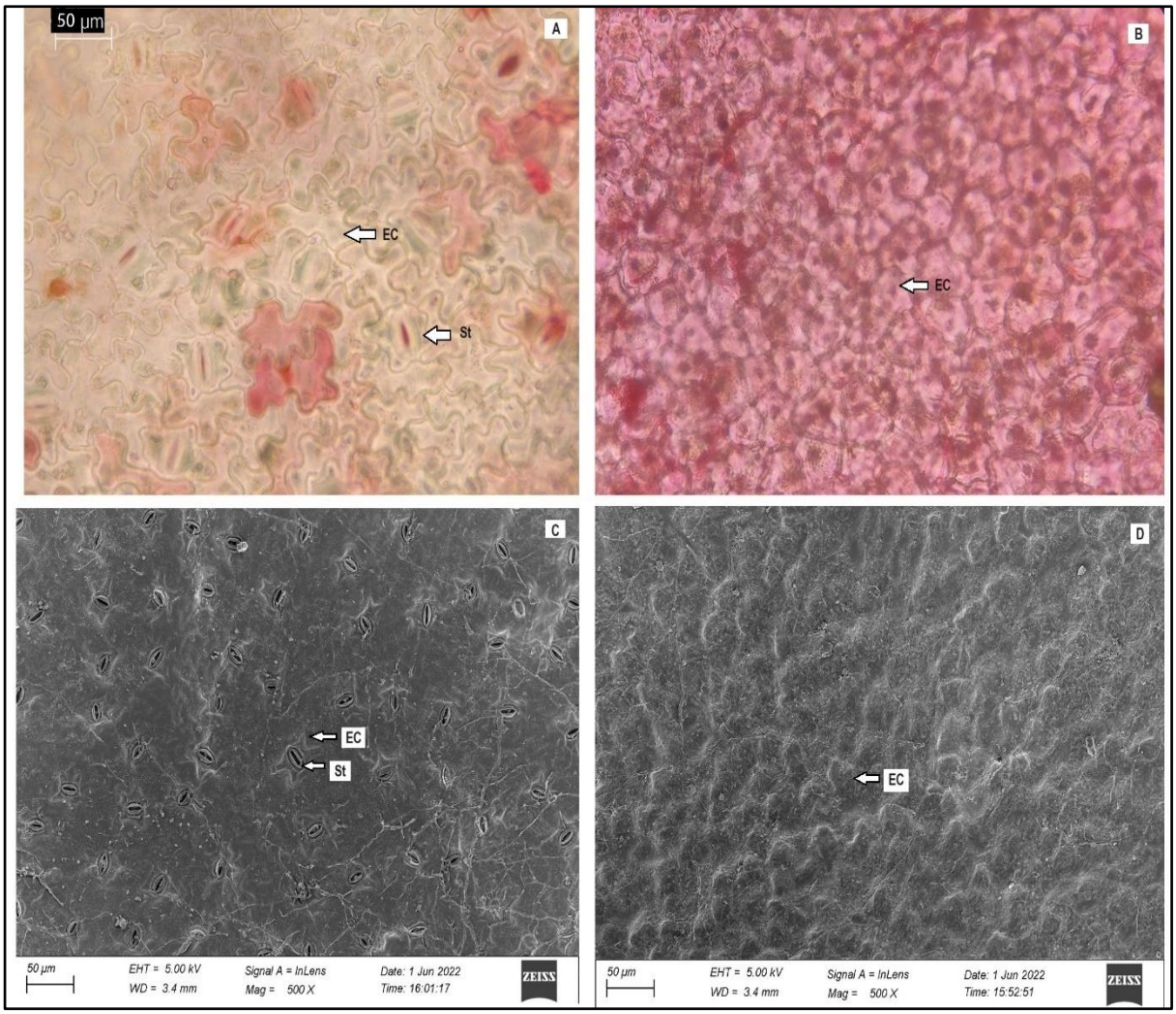

Plate 16. ***Glochidion sphaerogynum*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell. Scale bars = 50 µm (A, B, C, D).

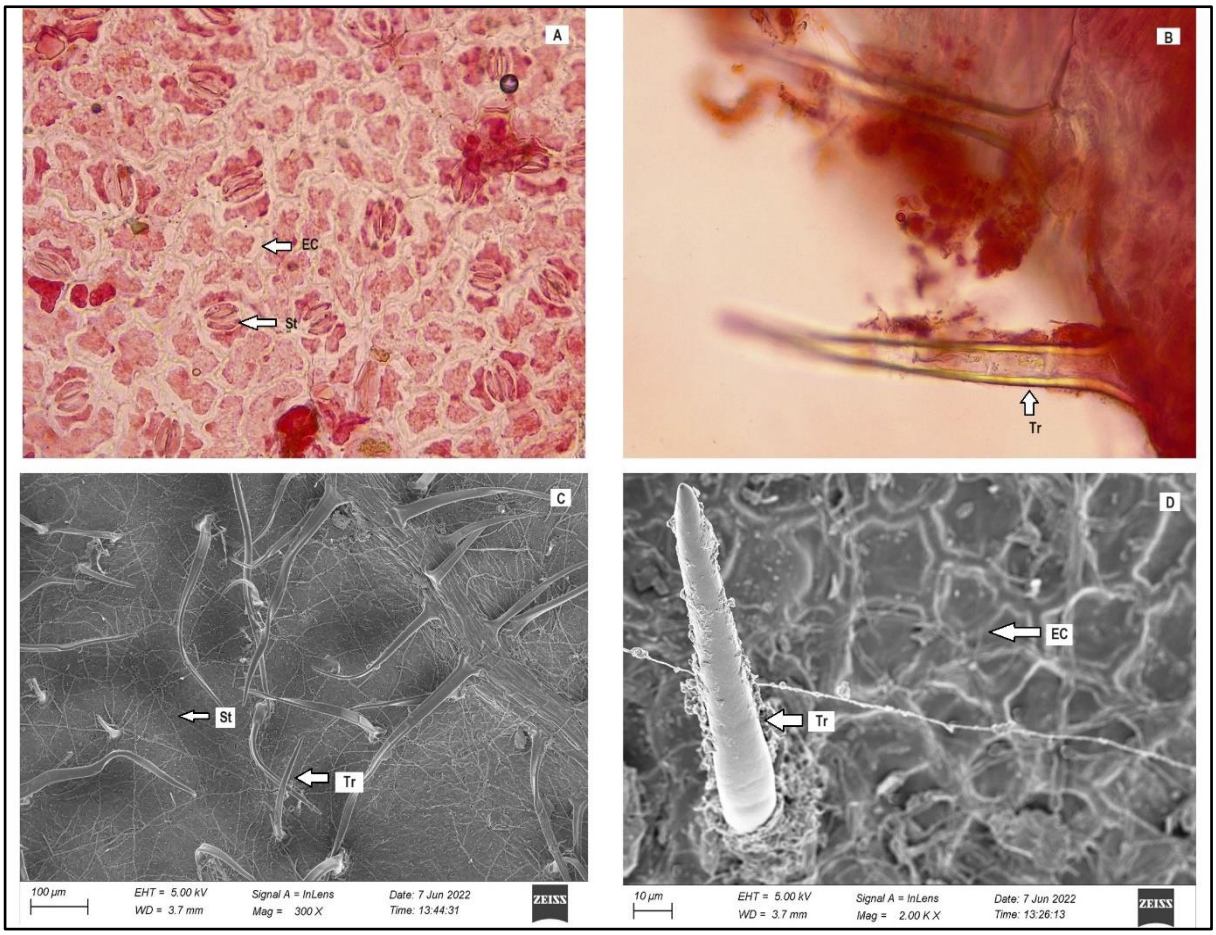

Plate 17. ***Glochidion zeylanicum*** var. ***arborescens*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell, Tr: Trichome. Scale bars = 50 µm (A, B), 100 µm (C), 10 µm (D).

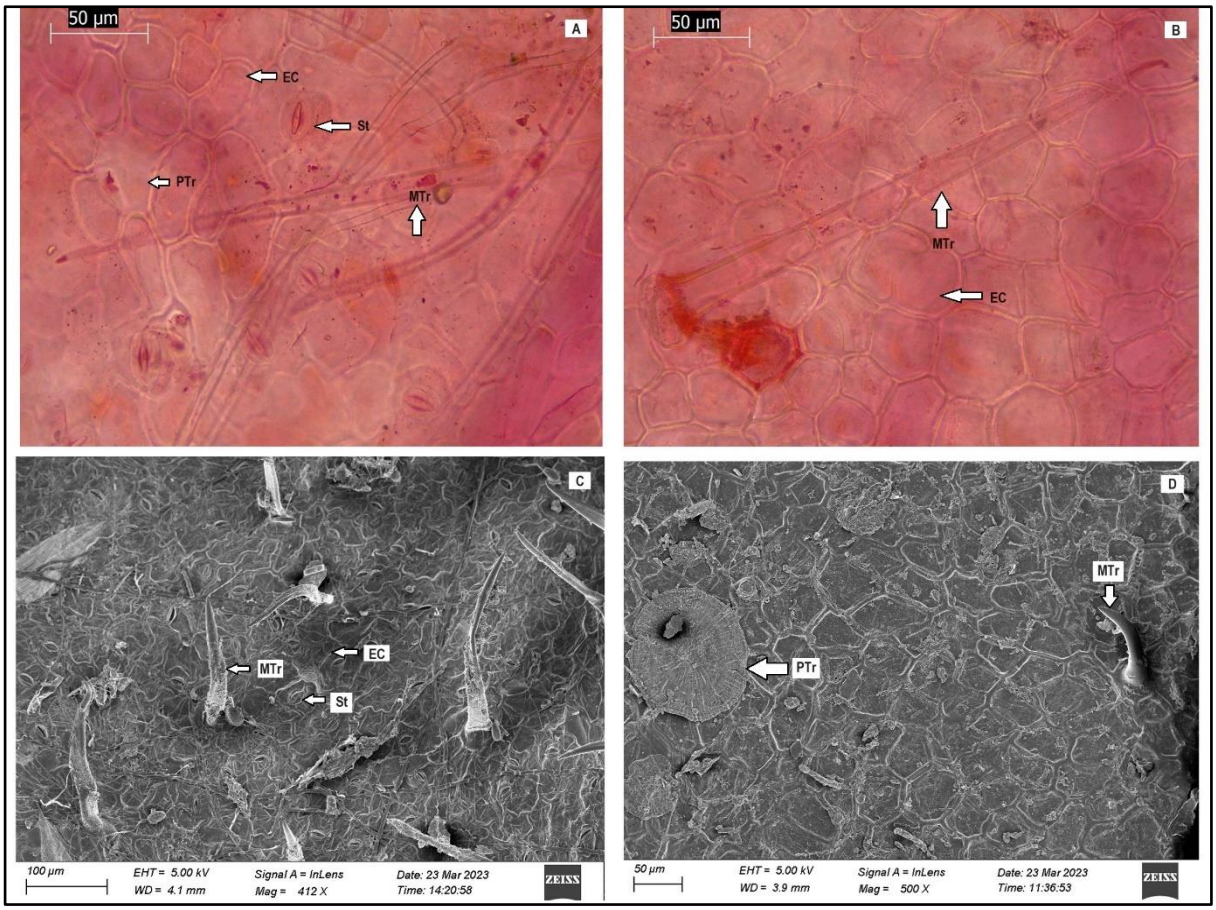

Plate 18. ***Glochidion zeylanicum*** var. ***paucicarpum*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell, MTr: Multicellular Trichome, PTr: Peltate trichome. Scale bars = 50 µm (A, B, D), 100 µm (C).

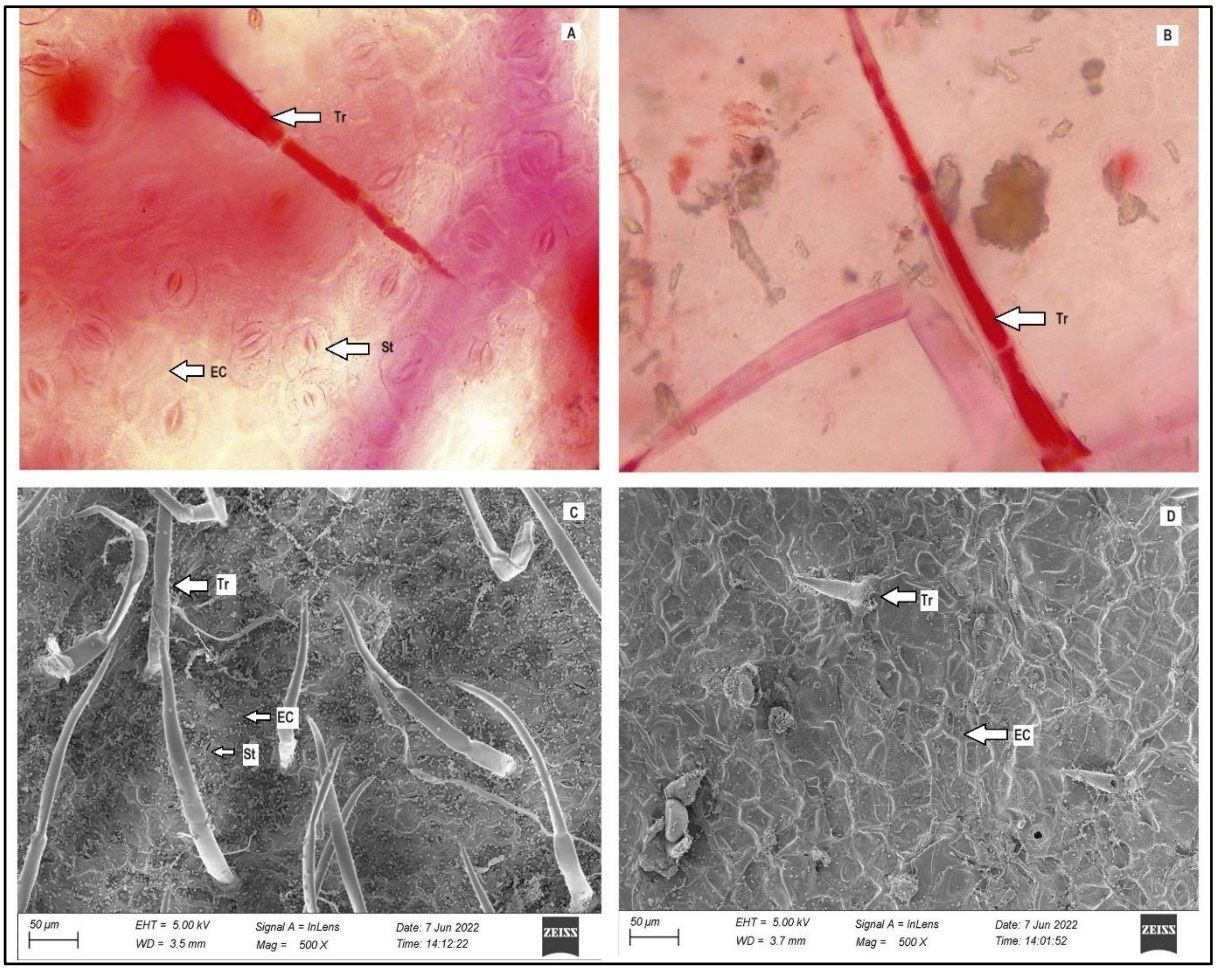

Plate 19. ***Glochidion zeylanicum*** var. ***tomentosum*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell, Tr: Trichome. Scale bars = 50 µm (A, B, C, D).

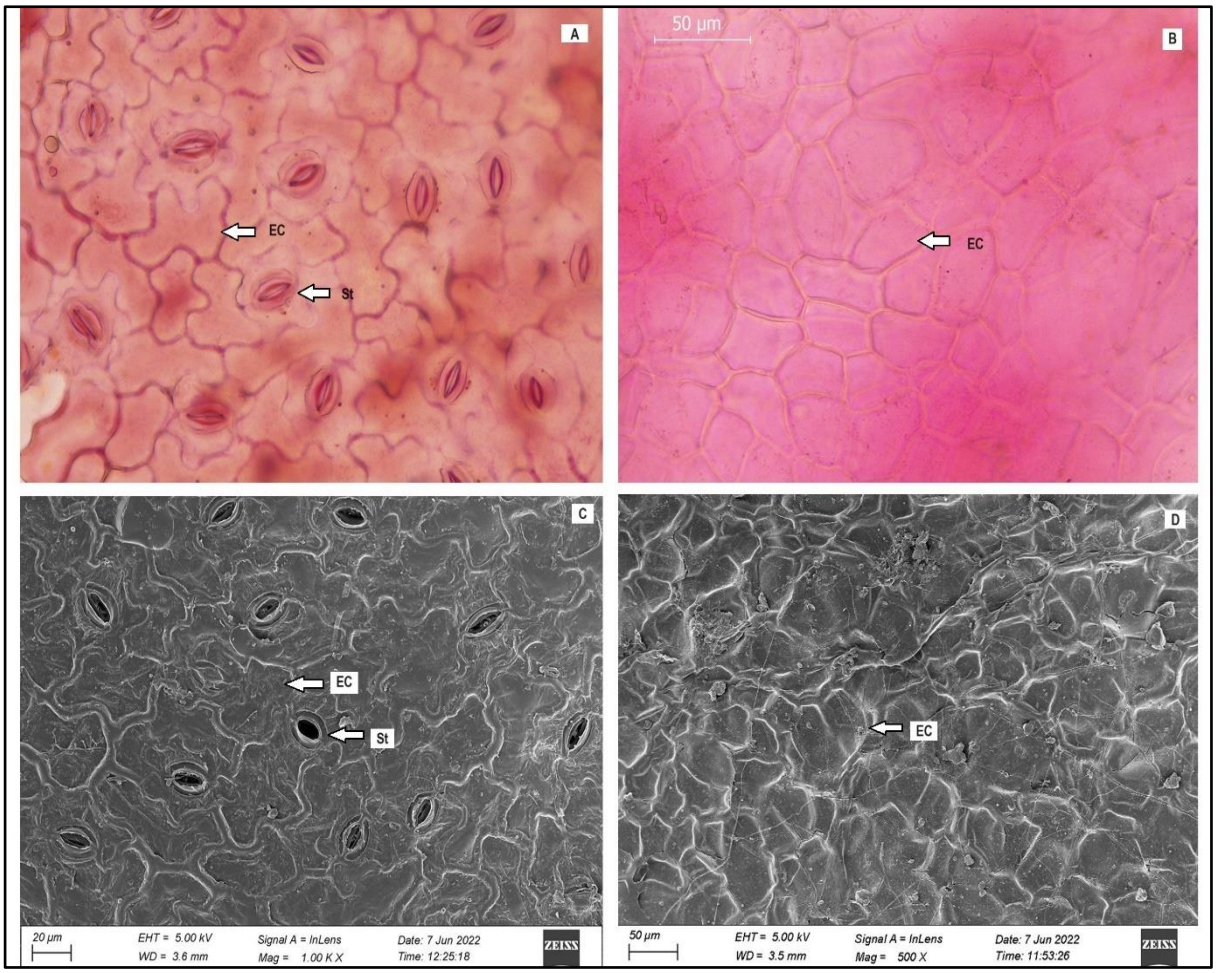

Plate 20. ***Glochidion zeylanicum*** var. ***zeylanicum*** **A-B.** Light micrographs (LM) of the abaxial and adaxial surface of foliar leaf epidermal features, 40X **C-D.** Field emission scanning electron micrographs (FESEM) of the abaxial and adaxial surface of foliar leaf epidermal features. St: Stomata, EC: Epidermal Cell. Scale bars = 50 µm (A, B, D), 20 µm (C).

4.4. Petiole anatomical study

4.4.1. Key to the species and varieties

1a. Epidermal hairs present…….**2**

1b. Epidermal hairs absent…….....**5**

2a. Parenchyma cells 4–5 layers……**2. *G. heyneanum***

2b. Parenchyma cells 2–3 layers……**5. *G. multiloculare*** var. ***pubescens***

3a. Outline is circular, slightly ridged shaped,

1–2 layers of hypodermis……..**4**

3b. Outline is circular, shield shaped, 1 layer

of hypodermis…….**9. *G. zeylanicum*** var. ***tomentosum***

4a. Vascular bundles are arc shaped median arranged

along with five distinct smaller bundles in the centre.……...**7. *G. zeylanicum*** var. ***arborescens***

4b. Vascular bundles are arc to wing

shaped arranged in the centre ……**8. *G. zeylanicum*** var. ***paucicarpum***

5a. Druse and prismatic crystals are present in collenchyma

and parenchyma cells as well as near the vascular bundle……**10. *G. zeylanicum*** var. ***zeylanicum***

5b. Druse, prismatic crystals and raphides are present

in collenchyma and parenchyma cells……**6. *G. sphaerogynum***

6a. Arc shaped median along with two to four distinct

small vascular bundle is arranged in the centre.…….**4. *G. multiloculare*** var. ***multiloculare***

6b. Arc shaped median along with two distinct small

vascular bundle is arranged in the centre.……**7**

7a. Outline of petiole is circular, and slightly ridged ……**1. *G. ellipticum***

7b. Outline of petiole is circular…….....**3. *G. lanceolarium***

1. *Glochidion ellipticum* Wight

The transverse section of the petiole is circular and slightly ridged in outline. Epidermal hairs are absent. A thick cuticle is present, followed by the epidermis. 1 layer of hypodermis is present, then 2 layers of collenchyma cells and 6–7 layers of parenchyma cells are present. Many druse and prismatic crystals were distributed in collenchyma and parenchyma cells. A ring of sclerenchymatous patches is present around the vascular bundle. A crescent or arc shaped median along with two distinct small vascular bundles are arranged in the centre. **(Plate 21)**

2. *Glochidion heyneanum* (Wight & Arn.) Wight

The transverse section of the petiole is circular and slightly ridged in outline. Non-glandular, simple multicellular hairs or trichomes are present on the epidermal layer. A thick cuticle is present. 1 layer of hypodermis is followed by 2–3 layers of collenchyma cell and then 4–5 layers of parenchyma cell. A ring of sclerenchymatous patches is present around the vascular bundle. Druse and prismatic crystals are present around collenchyma cells. A crescent or arc shaped median along with two distinct small vascular bundles are arranged in the centre. **(Plate 22)**

3. *Glochidion lanceolarium* (Roxb.) Voigt

The transverse section of the petiole is circular in outline. Trichomes or epidermal hairs are absent. A thick cuticle is present, followed by the epidermis. 2–3 layers of hypodermis have been observed followed by 4–5 layers of collenchyma cells and then 7–10 layers of parenchyma cells. A ring of sclerenchymatous patches is present around the vascular bundle. Druse and prismatic crystals were distributed around the collenchyma and parenchyma cells. Arc shaped median along with two distinct small vascular bundles are arranged in the centre. **(Plate 23)**

4. *Glochidion multiloculare* (Rottler ex Willd.) Voigt var. ***multiloculare***

The Transverse section of the petiole is almost circular or shield-shaped in outline. Epidermal cells are barrel-shaped with thick cuticles. Epidermal hairs or trichomes are absent. A thick cuticle with an epidermis is followed by 1–2 layers of the hypodermis. 2–3 layers of collenchyma cells are present, followed by 7–8 layers of parenchyma cells. A ring of sclerenchymatous patches is present around the vascular bundle. Druse and prismatic crystals were distributed around the collenchyma and parenchyma cells. Arc shaped median along with two to four distinct small vascular bundles are arranged in the centre. **(Plate 24)**

5. *Glochidion multiloculare* var. ***pubescens*** Chakrab. & M.Gangop.

The transverse section of the petiole is circular or shield shaped in outline. Non-glandular, simple multicellular trichomes are present. A thick cuticle with an epidermis is followed by 1 layer of the hypodermis. 2–5 layers of collenchyma cells are present, followed by 2–3 layers of parenchyma cells. Druse and prismatic crystals were present around the collenchyma and parenchyma cells. A ring of sclerenchymatous patches is present around the vascular bundle. The vascular bundle was arranged in a ring in the centre, collateral, open, 7–9 in number. Xylem and phloem, bundle sheath, the middle vascular bundle is crescent shaped. Collenchyma, phloem cells contain tannin-like structures. Arc shaped median along with two distinct small vascular bundles are arranged in the centre. **(Plate 25)**

6. *Glochidion sphaerogynum* (Mull.Arg.) Kurz

The transverse section of the petiole is circular, ridged, and wavy in outline. Epidermal hairs are absent. A thick cuticle is present, followed by the epidermis. 2–3 layers of hypodermis have been observed followed by 4–5 layers of collenchyma cells and then 10–12 layers of parenchyma cells. A ring of sclerenchymatous patches is present around the vascular bundle. Druse, prismatic crystals, and raphides were present near the vascular bundle or around the parenchyma cells. Vascular bundles are arc shaped median arranged along with three distinct smaller bundles in the centre. **(Plate 26)**

7. *Glochidion zeylanicum* var. ***arborescens*** (Blume) Chakrab. & M.Gangop.

The transverse section of the petiole is circular and slightly ridged in outline. Long, non-glandular, simple, multicellular hairs are present. A thick cuticle is present followed by the epidermis. 1–2 layers of hypodermis have been observed followed by 7–8 layers of collenchyma cells and then 2–3 layers of parenchyma cells. A ring of sclerenchymatous patches is present around the vascular bundle. Druse, prismatic crystals were present around the parenchyma cells. Vascular bundles are arc shaped median arranged along with five distinct smaller bundles in the centre. **(Plate 27)**

8. *Glochidion zeylanicum* var. ***paucicarpum*** Chakrab. & N.P. Balakr.

The transverse section of the petiole is circular and slightly ridged in outline. Non-glandular multicellular hairs are present. A thick cuticle is present which is followed by the epidermis. 1–2 layers of hypodermis have been observed followed by 6–8 layers of collenchyma cells and then 3–4 layers of parenchyma cells. A ring of sclerenchymatous patches are present around the vascular bundle. A ring of sclerenchymaous patches is present around the vascular bundle. High number of druses, prismatic crystals were present around the collenchyma and parenchyma cells and less number of druse, prismatic crystals were observed inside the vascular bundle. Arc and wing shaped vascular bundles are arranged in the centre. **(Plate 28)**

9. *Glochidion zeylanicum* var. ***tomentosum*** Trimen

The transverse section of the petiole is circular in outline. Non-glandular, simple, multicellular hairs are present. A thick cuticle is present which is followed by the epidermis. 1 layer of hypodermis has been observed followed by 6–7 layers of collenchyma cells and then 2–3 layers of parenchyma cells. A ring of sclerenchymatous patches is present around the vascular bundle. Druse and prismatic crystals were present around the collenchyma and parenchyma cells. Crescent-shaped or arc shaped along with two distinct smaller vascular bundles are arranged in a ring in the centre. **(Plate 29)**

10. *Glochidion zeylanicum* (Gaertn.) A.Juss. var. ***zeylanicum***

The transverse section of the petiole is circular in outline. Epidermal hairs are absent. A thick cuticle is present and followed by the epidermis. 1 layer of hypodermis has been observed followed by 5–6 layers of collenchyma cells and then 3–5 layers of parenchyma cells. Both druse and prismatic crystals were distributed around the collenchyma,

parenchyma cells as well as near the vascular bundles. A ring of sclerenchymatous patches is present around the vascular bundle. Vascular bundles are arc-shaped arranged along with three distinct small bundles in the centre. Druse-like crystals have been observed in collenchyma and parenchyma cells. **(Plate 30)**

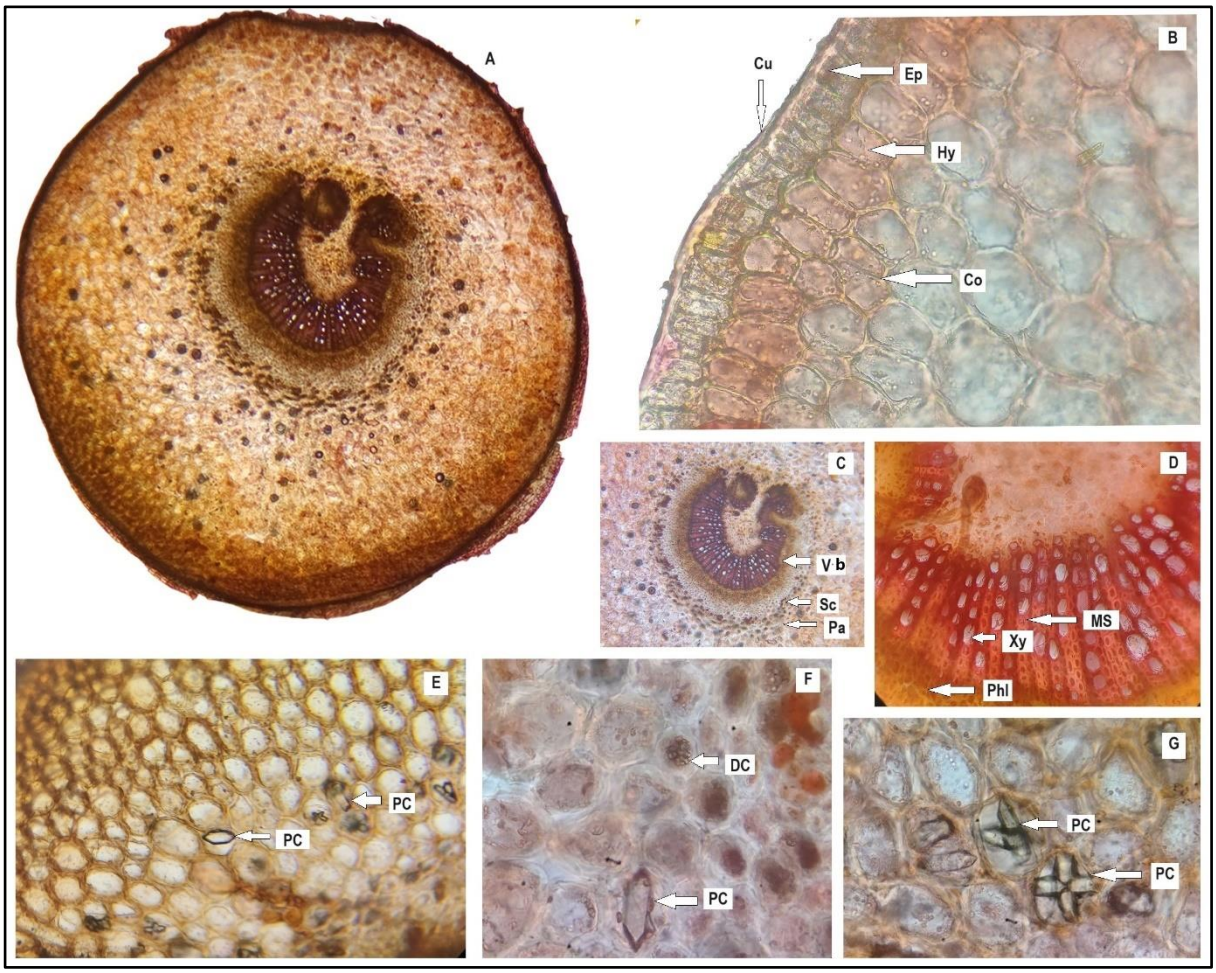

Plate 21. ***Glochidion ellipticum*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C-D.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), Medullary Scleried (MS) along with Sclerenchyma (Sc), Parenchyma (Pa), 40X **E-G.** Crystals types, Prismatic Crystal (PC), Druse Crystal (DC), 40X.

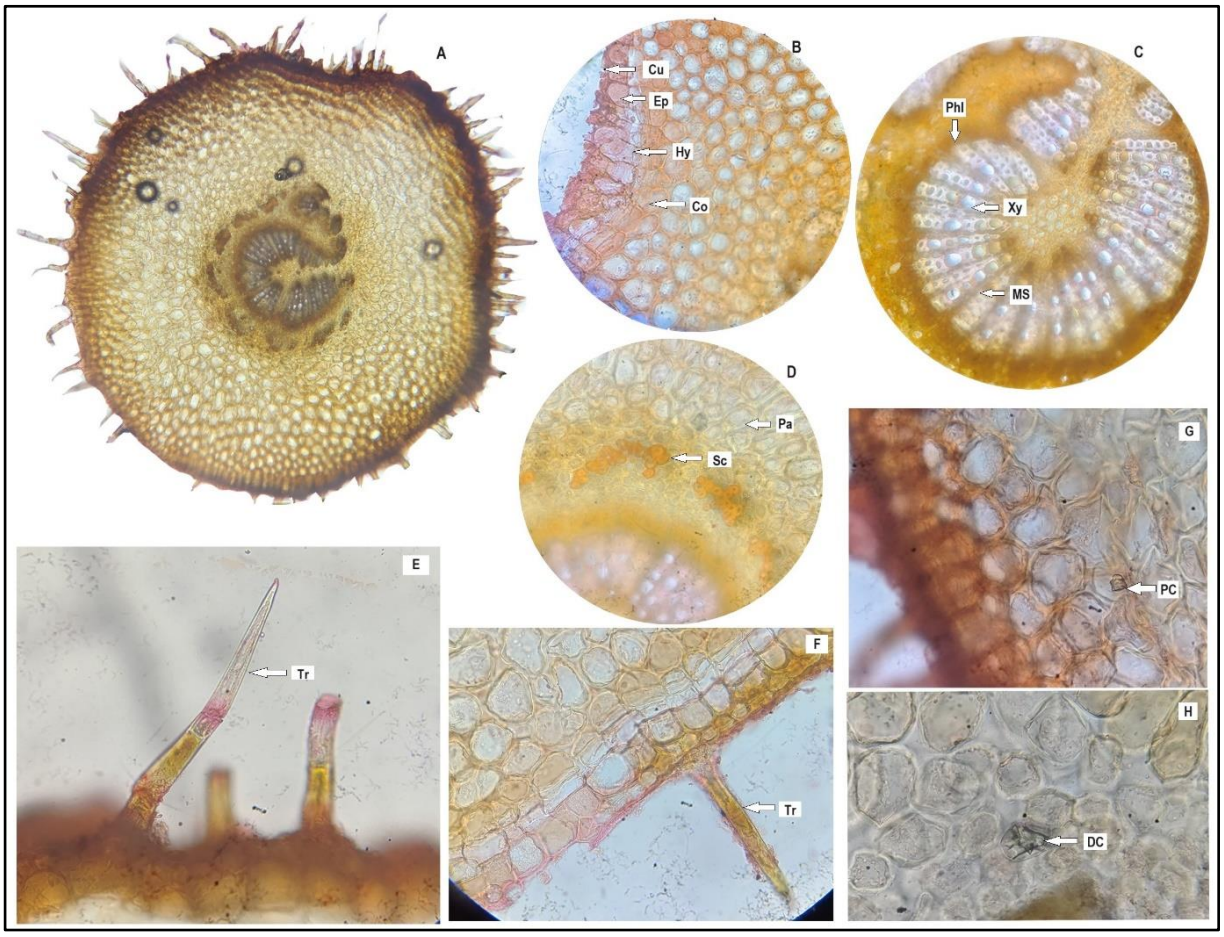

Plate 22. ***Glochidion heyneanum*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C-D.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), Medullary Scleried (MS) along with Sclerenchyma (Sc), Parenchyma (Pa), 10X, 40X **E-F.** Trichome (Tr), 40X **G-H.** Crystals types, Prismatic Crystal (PC), Druse Crystal (DC), 40X.

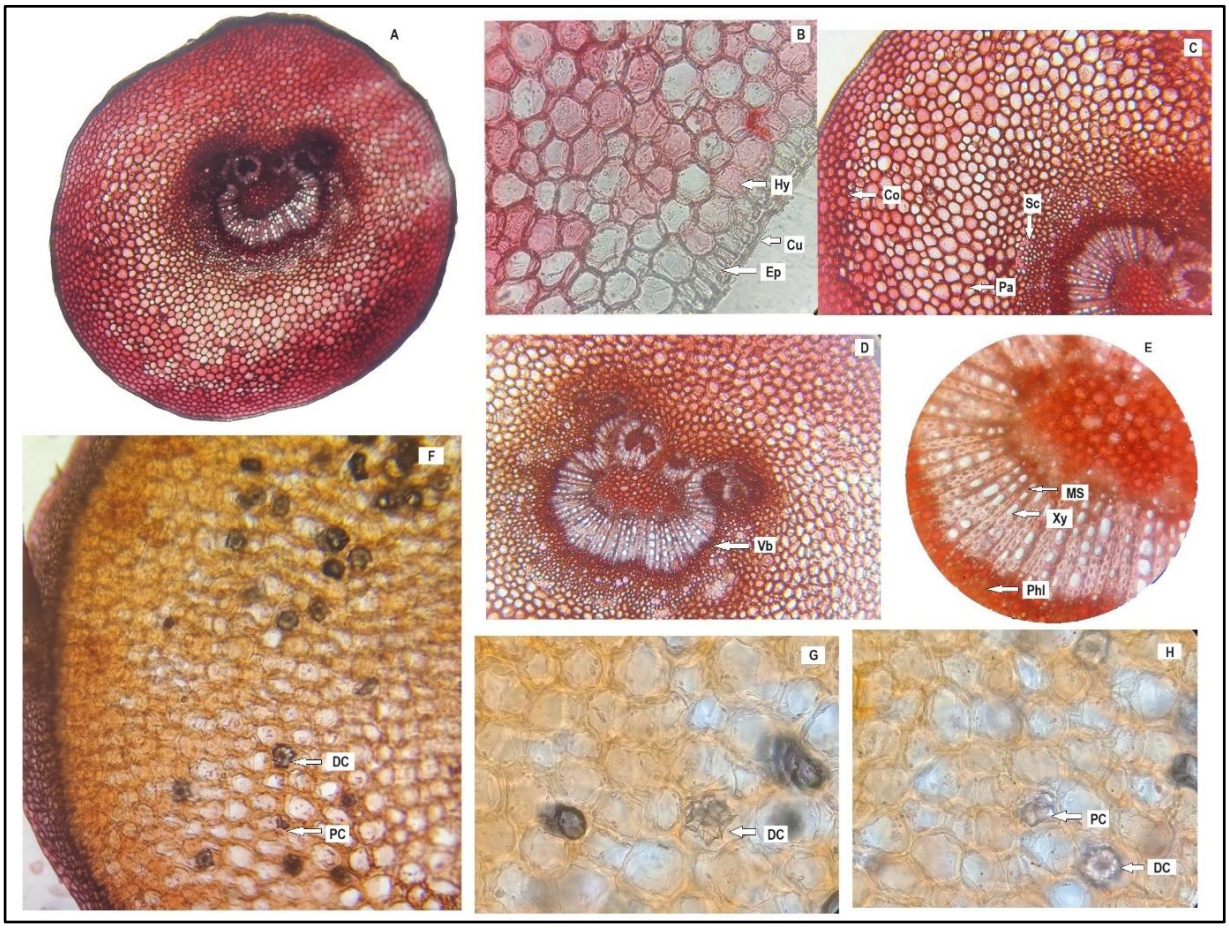

Plate 23. ***Glochidion lanceolarium*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), 40X **C.** Collenchyma (Co), Sclerenchyma (Sc), Parenchyma (Pa), 40X **D-E.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), Medullary Scleried (MS), 40X **F-H.** Crystals types, Prismatic Crystal (PC), Druse Crystal (DC), 40X.

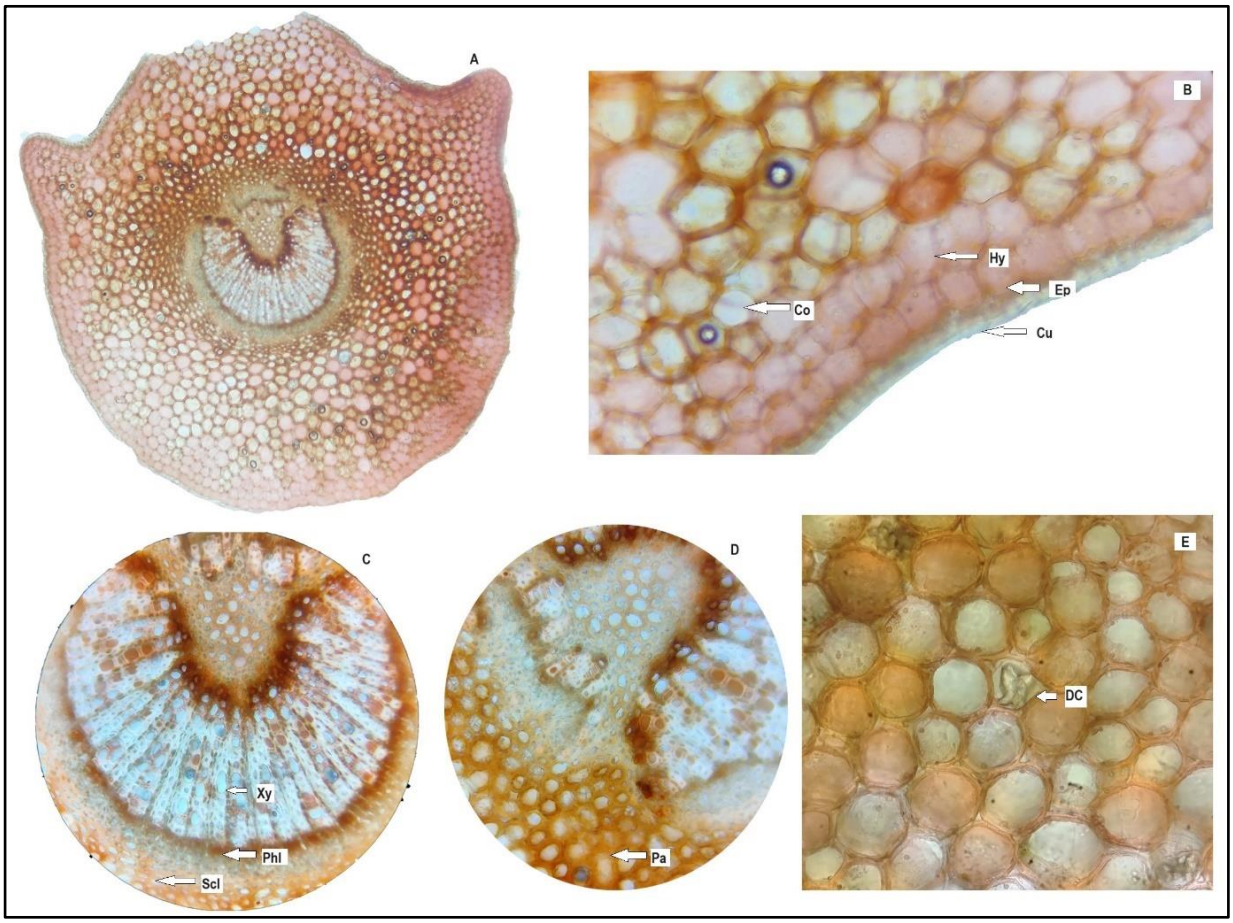

Plate 24. ***Glochidion multiloculare*** var. ***multiloculare*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C-D.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), along with Sclerenchyma (Sc), Parenchyma (Pa), 10X, 40X **E.** Druse Crystal (DC), 40X.

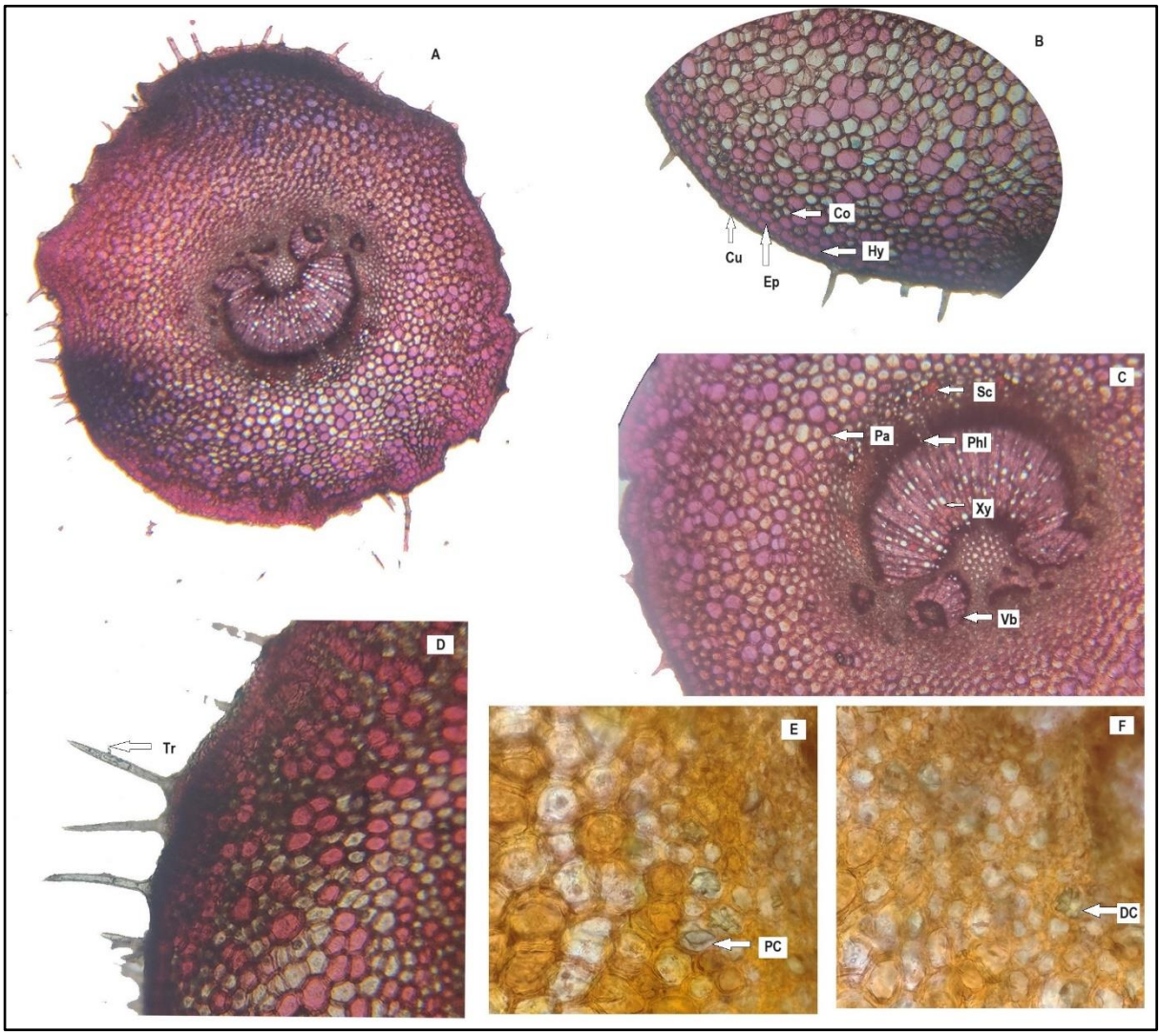

Plate 25. ***Glochidion multiloculare*** var. ***pubescens*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), along with Sclerenchyma (Sc), Parenchyma (Pa), 40X **D.** Trichome (Tr), 40X **E-F.** Crystals types, Prismatic Crystal (PC), Druse Crystal (DC), 40X.

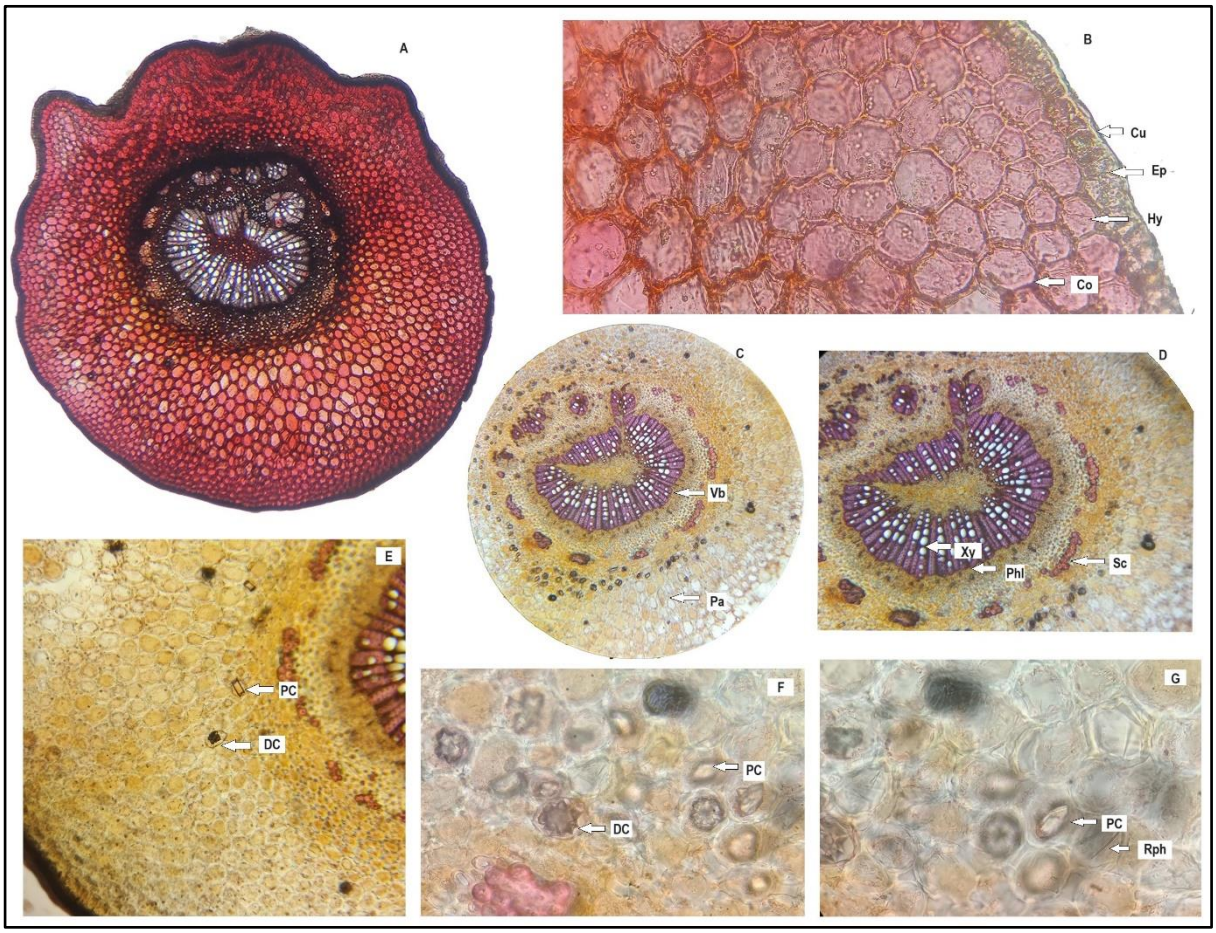

Plate 26. ***Glochidion sphaerogynum*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C-D.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), along with Sclerenchyma (Sc), Parenchyma (Pa), 40X **E-F.** Crystals types, Prismatic Crystal (PC), Druse Crystal (DC), 10X, 40X. **G.** Prismatic Crystal (PC), Raphides (Rph), 40X.

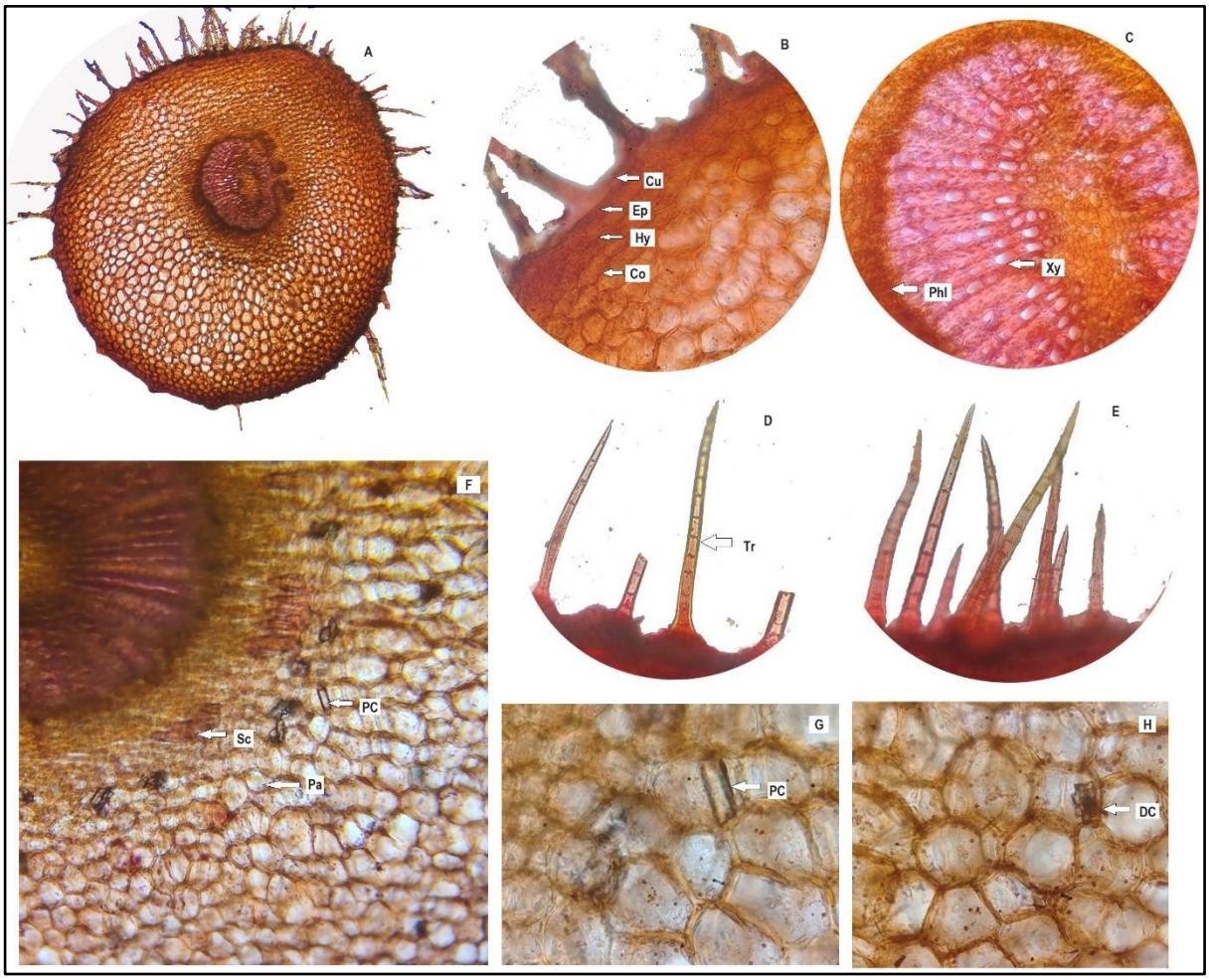

Plate 27. ***Glochidion zeylanicum*** var. ***arborescens*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), 40X **D-E.** Trichome (Tr), 40X **F.** Sclerenchyma (Sc), Parenchyma (Pa), Prismatic Crystal (PC), 40X **G-H.** Crystals types, Prismatic Crystal (PC), Druse Crystal (DC), 40X.

Plate 28. ***Glochidion zeylanicum*** var. ***paucicarpum*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), along with Sclerenchyma (Sc), Parenchyma (Pa), Prismatic Crystal (PC), Druse Crystal (DC), 40X **D-E.** Trichome (Tr), 40X **F.** Druse Crystal (DC), 40X.

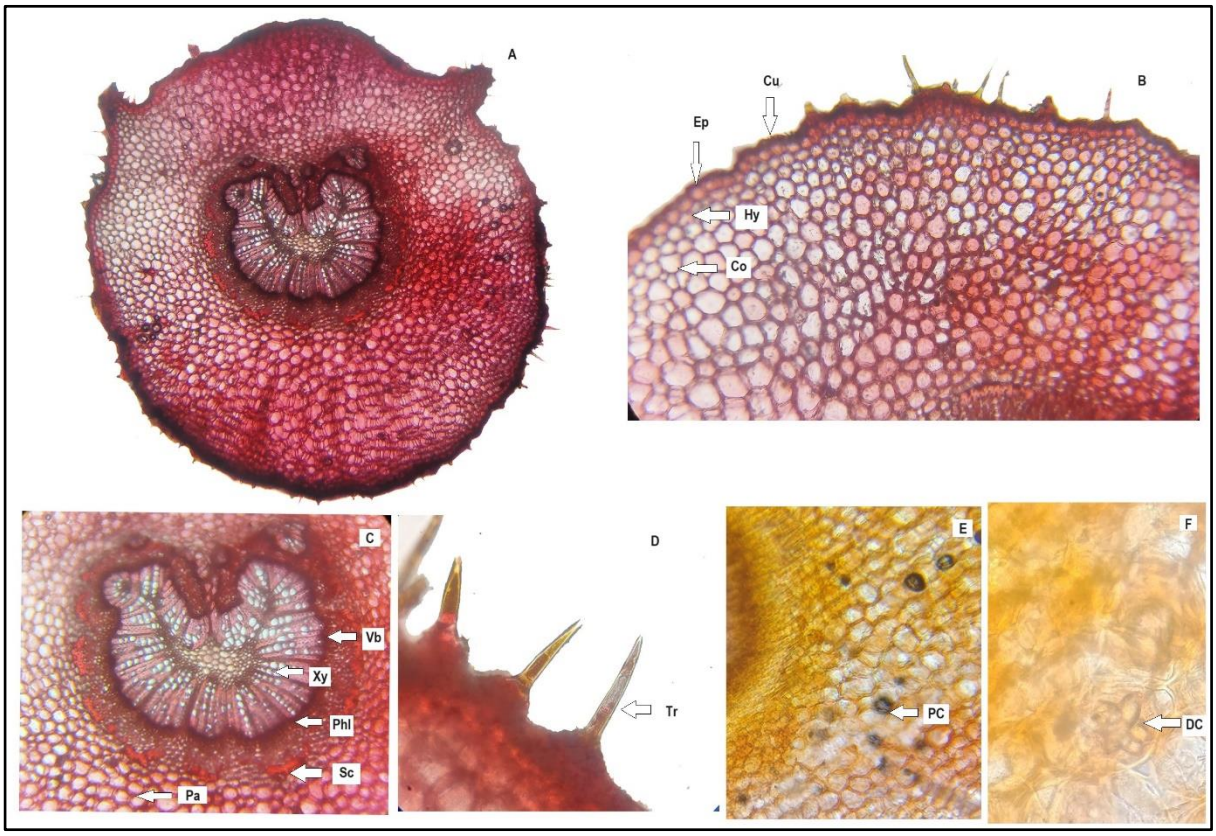

Plate 29. ***Glochidion zeylanicum*** var. ***tomentosum*** **A.** T.S. of petiole, 10X **B.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), 40X **C.** Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), along with Sclerenchyma (Sc), Parenchyma (Pa), 40X **D.** Trichome (Tr), 40X **E-F.** Crystals types, Prismatic Crystal (PC), Druse Crystal (DC), 40X.

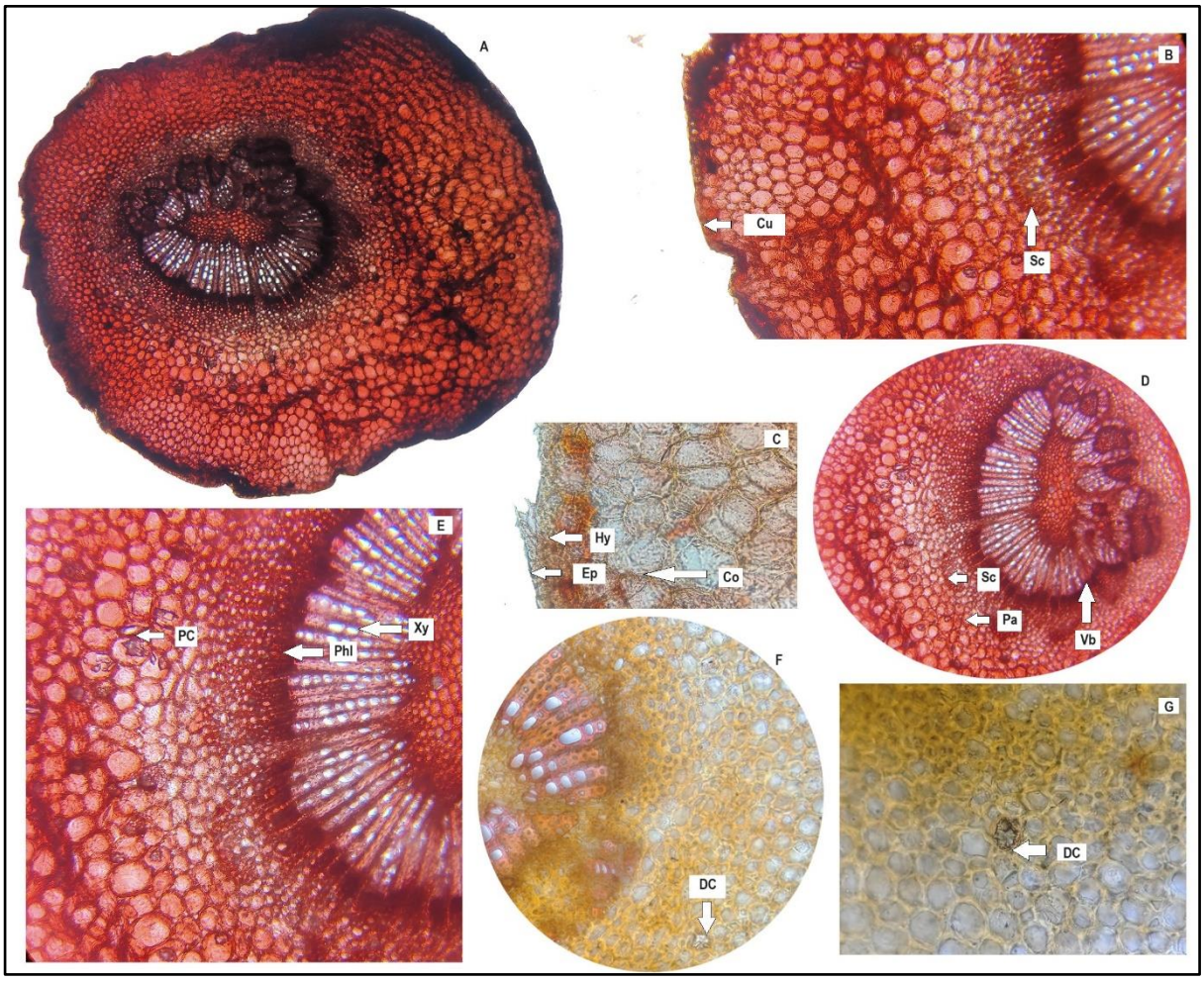

Plate 30. ***Glochidion zeylanicum*** var. ***zeylanicum*** **A.** T.S. of petiole, 10X **B-E.** Showing Cuticle (Cu), Epidermis (Ep), Hypodermis (Hy), Collenchyma (Co), Vascular bundle (Vb) showing Xylem (Xy), Phloem (Phl), Sclerenchyma (Sc), Parenchyma (Pa), Prismatic Crystal (PC), 40X **F-G.** Druse Crystal (DC), 40X.

4.5. Leaf architecture study

4.5.1. Key to the species and varieties

1a. 2º vein category weak brochidodromous to hemieucamptodromous……..**2**

1b. 2º vein category weak brochidodromous……**3**

2a. 5º vein category irregular reticulate to dichotomizing……**4. *G. multiloculare*** var. ***multiloculare***

2b. 5º vein category freely ramifying……**5. *G. multiloculare*** var. ***pubescens***

3a. 3º vein category decurrent……**4**

3b. 3º vein category sinuous to percurrent……**2. *G. heyneanum***

4a. Leaf shape elliptic, ovate to lanceolate……**8. *G. zeylanicum*** var. ***paucicarpum***

4b. Leaf shape ovate to elliptic, cordate……..**5**

5a. Leaf obcordate, acute at apex and obtuse, truncate, asymmetric at base……..**9. *G. zeylanicum*** var. ***tomentosum***

5b. Leaf acute, apiculate at apex and cordate, asymmetric, truncate at base……**10. *G. zeylanicum*** var. ***zeylanicum***

6a. The range of vein termination number is 98–105 per mm square……...**3. *G. lanceolarium***

6b. The range of vein termination number is 121–133 per mm square……**1. *G. ellipticum***

7a. Vein islet number ranges from 62–88 per mm square……**6. *G. sphaerogynum***

7b. Vein islet number ranges from 59–68

per mm square…….....**7. *G. zeylanicum*** var. ***arborescens***

1. *Glochidion ellipticum* Wight

Leaf arrangement is alternate, organization is simple, elliptic to lanceolate, oblong to obovate, 4–25 cm in length and 2–8 cm in breadth, apiculate, caudate, acuminate at the apex and obtuse at the base. The surface is glabrous on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) venations are weak brochidodromous, and interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally or toward the base, 2° vein angle decreasing toward the base, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal 3° veins angle variability are decreasing proximally. The exterior tertiary course is absent. Quaternary (4°) vein fabric is irregularly reticulated to mixed percurrent. Quinternary (5°) vein fabric is freely ramifying. Areole development is moderate to good. Vein termination and islet numbers range from 121–133 and 80–94 per mm square respectively. Freely ending branching is dichotomous branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are found at the tip of the veinlet. **(Plate 31)**

2. *Glochidion heyneanum* (Wight & Arn.) Wight

Leaf arrangement is alternate, organization is simple, ovate to elliptic, obovate, 3–15 cm in length and 2–7 cm in breadth, acute, apiculate at the apex and obtuse or rounded at base. The surface is pubescent on both sides and densely pubescent beneath, margin is entire, untoothed, and unlobed. The primary (1°) vein category is pinnate, naked basal veins are absent, and agrophic veins are simple or absent. Secondary (2°) venations are simple, weak brochidodromous, interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally or toward the base, 2° vein angle decreasing proximally, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are sinuous to

percurrent and intercostal 3° vein angle variability is consistent. Exterior tertiary course is absent. Quaternary (4°) vein fabric is mixed percurrent. Quinternary (5°) vein fabric is irregular reticulate. Areole development is moderate to good. Vein termination and islet numbers range from 87–92 and 74–79 per mm square respectively. Freely ending branching is dichotomous branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are found at the tip of the veinlet. **(Plate 32)**

3. *Glochidion lanceolarium* (Roxb.) Voigt

Leaf arrangement is alternate, organization is simple, lanceolate to oblanceolate, elliptic, 4–27 cm in length and 2.5–8 cm in breadth, apiculate, acuminate or acute at the apex and obtuse or rounded at the base. The surface is glabrous on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) venations are weak brochidodromous, and interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally or toward the base, 2° vein angle decreasing toward the base, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal 3° vein angle variability is inconsistent. Exterior tertiary course is absent. Quaternary (4°) vein fabric is percurrent. Quinternary (5°) vein fabric is irregular reticulate. Areole development is moderate to good. Vein termination and islet numbers range from 98–105 and 66–72 per mm square respectively. Freely ending branching is one branched to dichotomously branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are observed at the tip of the veinlet. **(Plate 33)**

4. *Glochidion multiloculare* (Rottler ex Willd.) Voigt var. ***multiloculare***

Leaf arrangement is alternate, organization is simple, oblong to lanceolate, elliptic to oblanceolate, 4–16 cm in length and 2–6 cm in breadth, acute, apiculate or retuse at the apex and obtuse or rounded at the base. The surface is glabrous on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) venations are weak, simple brochidodromous to hemieucamptodromous, and interior secondary is absent.

Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally, 2° vein angle decreasing toward the base, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal tertiary (3°) vein angle variability is consistent to decreasing proximally. The exterior tertiary course is absent. Quaternary (4°) vein fabric is mixed percurrent. Quinternary (5°) vein fabric is irregular reticulate to dichotomizing. Areole development is moderate to good. Vein termination and islet numbers range from 127–135 and 97–111 per mm square respectively. Freely ending branching is one branched to dichotomously branched and freely ending veinlet terminals are simple. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are present at the tip of the veinlet. **(Plate 34)**

5. *Glochidion multiloculare* var. ***pubescens*** Chakrab. & M.Gangop.

Leaf arrangement is alternate, organization is simple, oblong to lanceolate, elliptic to oblanceolate, 4–15 cm in length and 2–6 cm in breadth, acute, apiculate or retuse at the apex and obtuse or rounded at the base. The surface is pubescent on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) venations are weak brochidodromous to hemieucamptodromous, interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally or toward the base, 2° vein angle decreasing toward the base, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal tertiary (3°) vein angle variability is decreasing proximally. Exterior tertiary course is absent. Quaternary (4°) vein fabric is mixed percurrent. Quinternary (5°) vein fabric is freely ramifying. Areole development is moderate. Vein termination and islet numbers range from 131–138 and 89–109 per mm square respectively. Freely ending branching is one branched to dichotomously branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are found at the tip of the veinlet. **(Plate 35)**

6. *Glochidion sphaerogynum* (Mull.Arg.) Kurz

Leaf arrangement is alternate, organization is simple, oblong to elliptic, falcate, 3–23 cm in length and 1.5–5.3 cm in breadth, acuminate at the apex and attenuate at base. The

surface is glabrous on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) veins are weak brochidodromous, interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally or toward the base, 2° vein angle is inconsistent, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal tertiary (3°) vein angle variability is consistent to decreasing proximally. Exterior tertiary course is absent. Quaternary (4°) vein fabric is mixed percurrent. Quinternary (5°) vein fabric is irregular polygonal, reticulate to dichotomizing. Areole development is moderate to good. Vein termination and islet numbers range from 93–103 and 62–88 per mm square respectively. Freely ending branching is dichotomous to dendritic branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are present at the tip of the veinlet. **(Plate 36)**

7. *Glochidion zeylanicum* var. ***arborescens*** (Blume) Chakrab. & M.Gangop.

Leaf arrangement is alternate, organization is simple, ovate to elliptic, 5–25 cm in length and 1.5–8.5 cm in breadth, acute, acuminate at the apex and obtuse or rounded at the base. The surface is densely pubescent on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) veins are weak brochidodromous, interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally, 2° vein angle decreasing proximally, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal tertiary (3°) vein angle variability is consistent to decreasing proximally. The exterior tertiary course is absent. Quaternary (4°) vein fabric is irregular reticulate to freely ramifying. Quinternary (5°) vein fabric is freely ramifying. Areole development is good. Vein termination and islet numbers range from 77–95 and 59–68 per mm square respectively. Freely ending branching is dichotomous to dendritic branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are present at the tip of the veinlet. **(Plate 37)**

8. *Glochidion zeylanicum* var. ***paucicarpum*** Chakrab. & N.P. Balakr.

Leaf arrangement is alternate, organization is simple, elliptic, ovate to lanceolate, 6–22 cm in length and 4–8 cm in breadth, acute at the apex and obtuse, truncate, rarely oblique, rounded at the base. The surface is densely pubescent on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) veins are weak brochidodromous, and interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing toward the base, 2° vein angle decreasing toward the base, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal tertiary (3°) vein angle variability is consistent to decreasing proximally. The exterior tertiary course is absent. Quaternary (4°) vein fabric is irregular reticulate to freely ramifying. Quinternary (5°) vein fabric is freely ramifying. Areole development is good. Vein termination and islet numbers range from 74–89 and 57–65 per mm square respectively. Freely ending branching is dichotomous to dendritic branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are found at the tip of the veinlet. **(Plate 38)**

9. *Glochidion zeylanicum* var. ***tomentosum*** Trimen

Leaf arrangement is alternate, organization is simple, ovate to elliptic, cordate, 5–20 cm in length and 3–8 cm in breadth, obcordate, acute at the apex and obtuse, truncate, asymmetric at the base. The surface is densely pubescent on both sides, margin is entire, untoothed, and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) veins are weak brochidodromous, and interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing decreasing proximally, 2° vein angle decreasing proximally, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are mixed percurrent and intercostal tertiary (3°) vein angle variability is consistent to decreasing proximally. The exterior tertiary course is absent. Quaternary (4°) vein fabric is irregular reticulate to freely ramifying. Quinternary (5°) vein fabric is freely ramifying. Areole development is good. Vein termination and islet numbers range from 80–91 and 65–71 per mm square respectively. Freely ending branching is dichotomous to dendritic branched and freely ending veinlet terminals are highly branched sclereids. Marginal

ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are observed at the tip of the veinlet. **(Plate 39)**

10. *Glochidion zeylanicum* (Gaertn.) A.Juss. var. ***zeylanicum***

Leaf arrangement is alternate, organization is simple, ovate to elliptic, cordate, 8–20 cm in length and 5–8 cm in breadth, acute, apiculate at the apex and cordate, asymmetric, truncate at the base. The surface is glabrous on both sides, margin is entire, untoothed and unlobed. Primary (1°) venation is pinnate, naked basal veins are absent, and agrophic veins are simple. Secondary (2°) veins are weak brochidodromous, interior secondary is absent. Perimarginal veins are intramarginal secondary, 2° vein spacing irregular to decreasing proximally or toward the base, 2° vein angle inconsistent to smoothly decreasing toward the base, secondary attachment to midvein is decurrent secondary attachment, and inter-2° veins are absent. Intercostal tertiary (3°) veins are sinuous to mixed percurrent and intercostal tertiary (3°) vein angle variability is decreasing exmedially. The exterior tertiary course is absent. Quaternary (4°) vein fabric is irregular reticulate to mixed percurrent. Quinternary (5°) vein fabric is irregular reticulate to freely ramifying. Areole development is good. Vein termination and islet numbers range from 81–94 and 66–83 per mm square respectively. Freely ending branching is dichotomous to dendritic branched and freely ending veinlet terminals are highly branched sclereids. Marginal ultimate venation (MUV) is looped. Bundle sheaths are well-developed in all veins. The clusters of tracheids are found at the tip of the veinlet. **(Plate 40)**

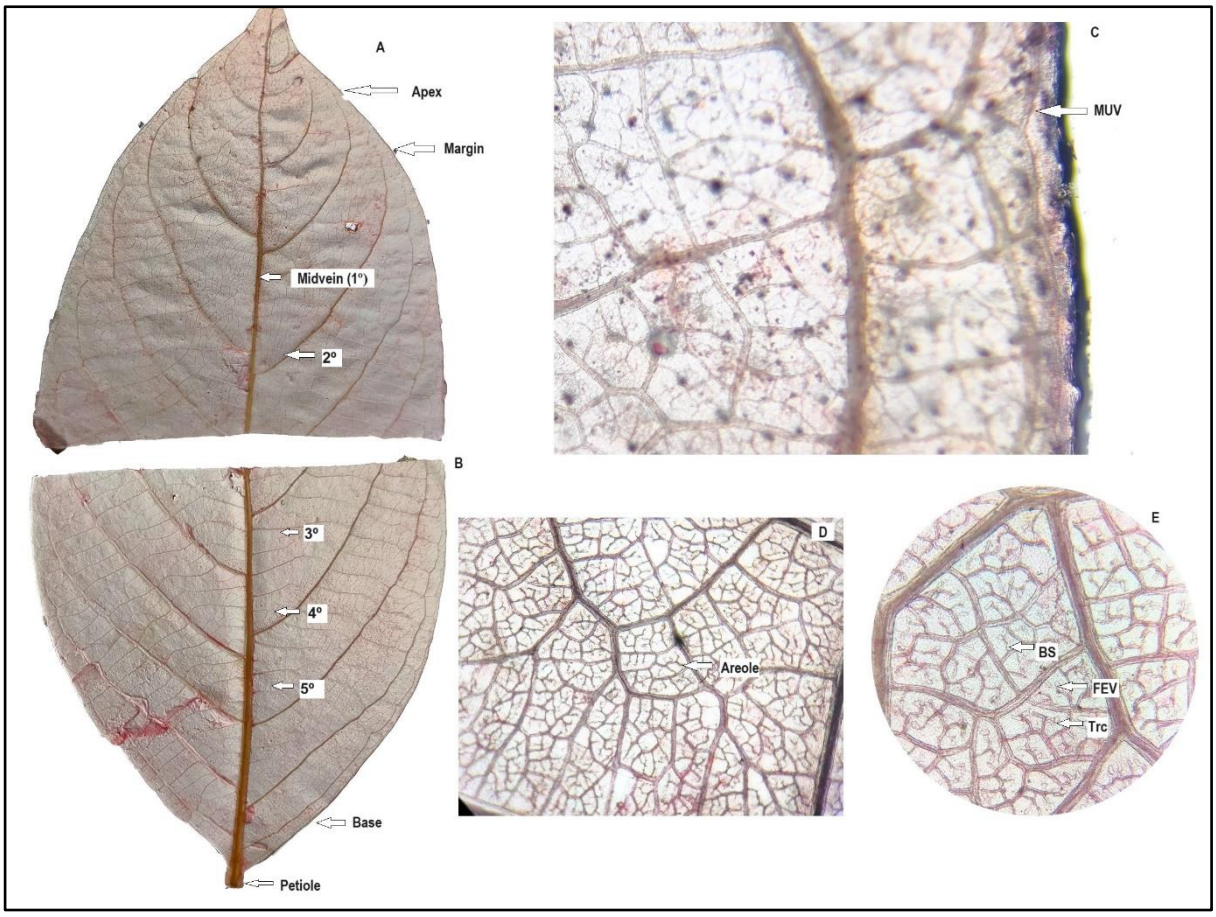

Plate 31. ***Glochidion ellipticum*** **A-B**. Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **C.** Marginal Ultimate Venation (MUV), 40X **D.** Areole, 10X **E.** Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc), 40X.

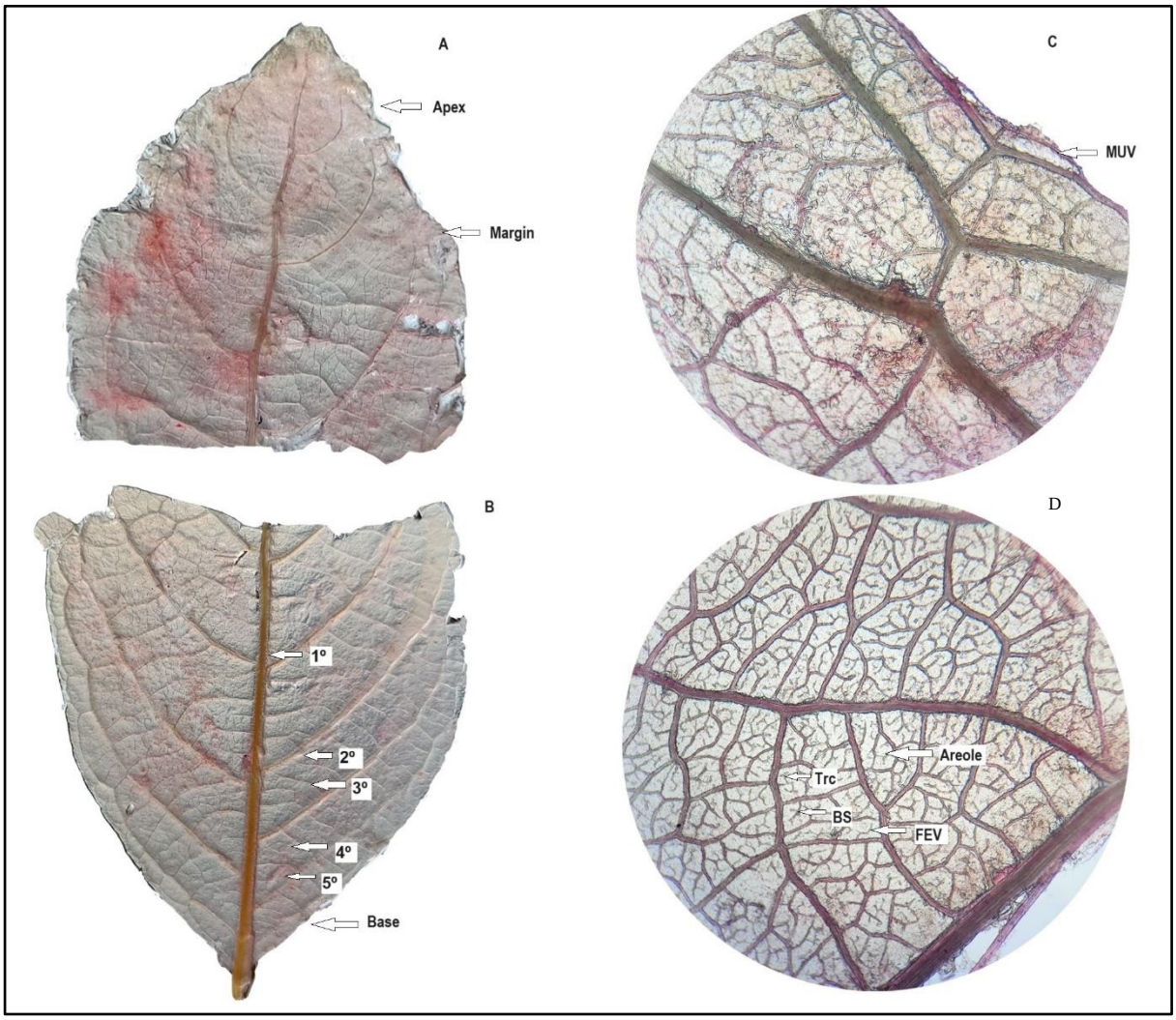

Plate 32. ***Glochidion heyneanum*** **A-B**. Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **C.** Marginal Ultimate Venation (MUV), 40X **D.** Areole, Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc), 10X.

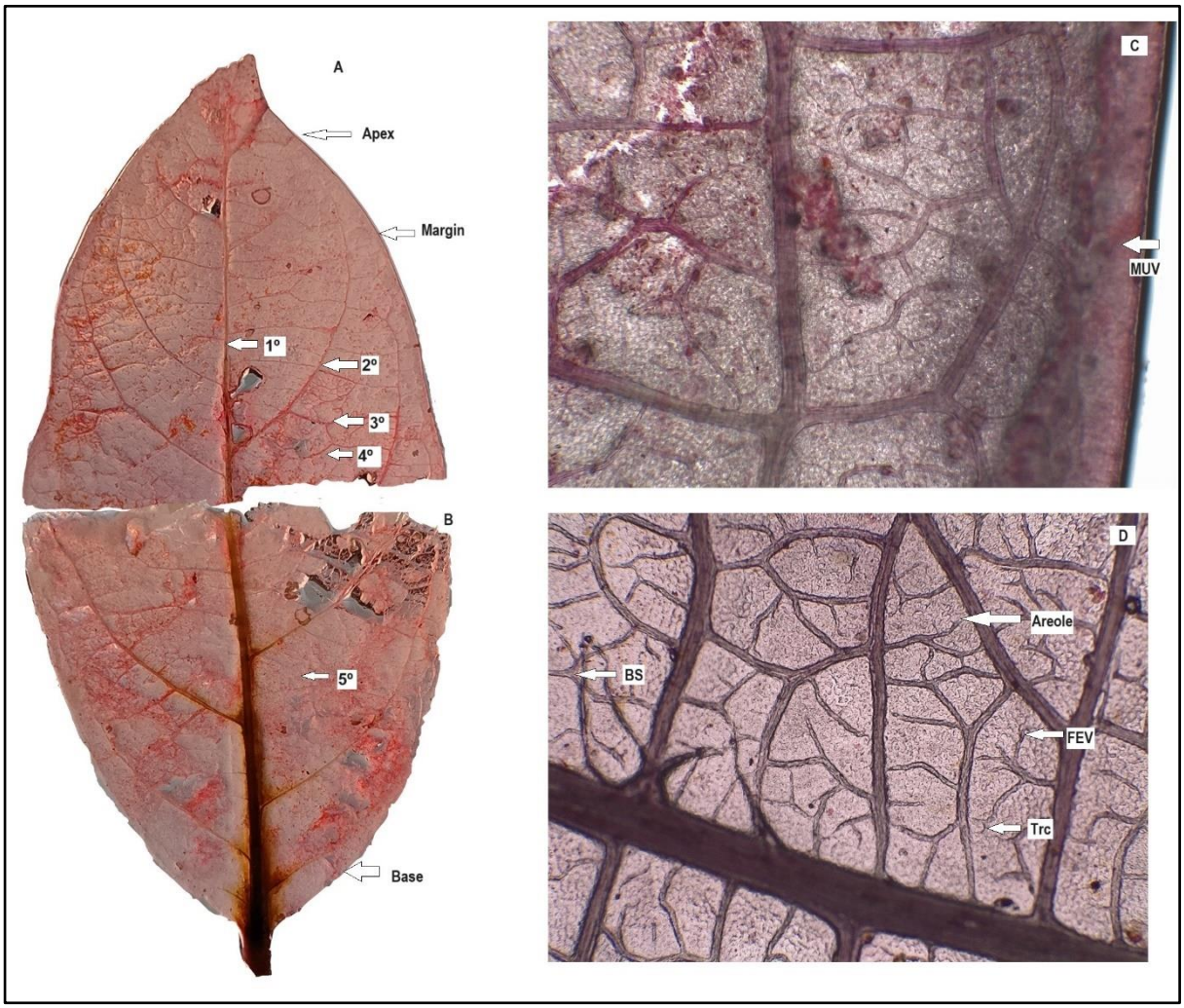

Plate 33. ***Glochidion lanceolarium*** **A-B**. Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **C.** Marginal Ultimate Venation (MUV), 40X **D.** Areole, Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc), 40X.

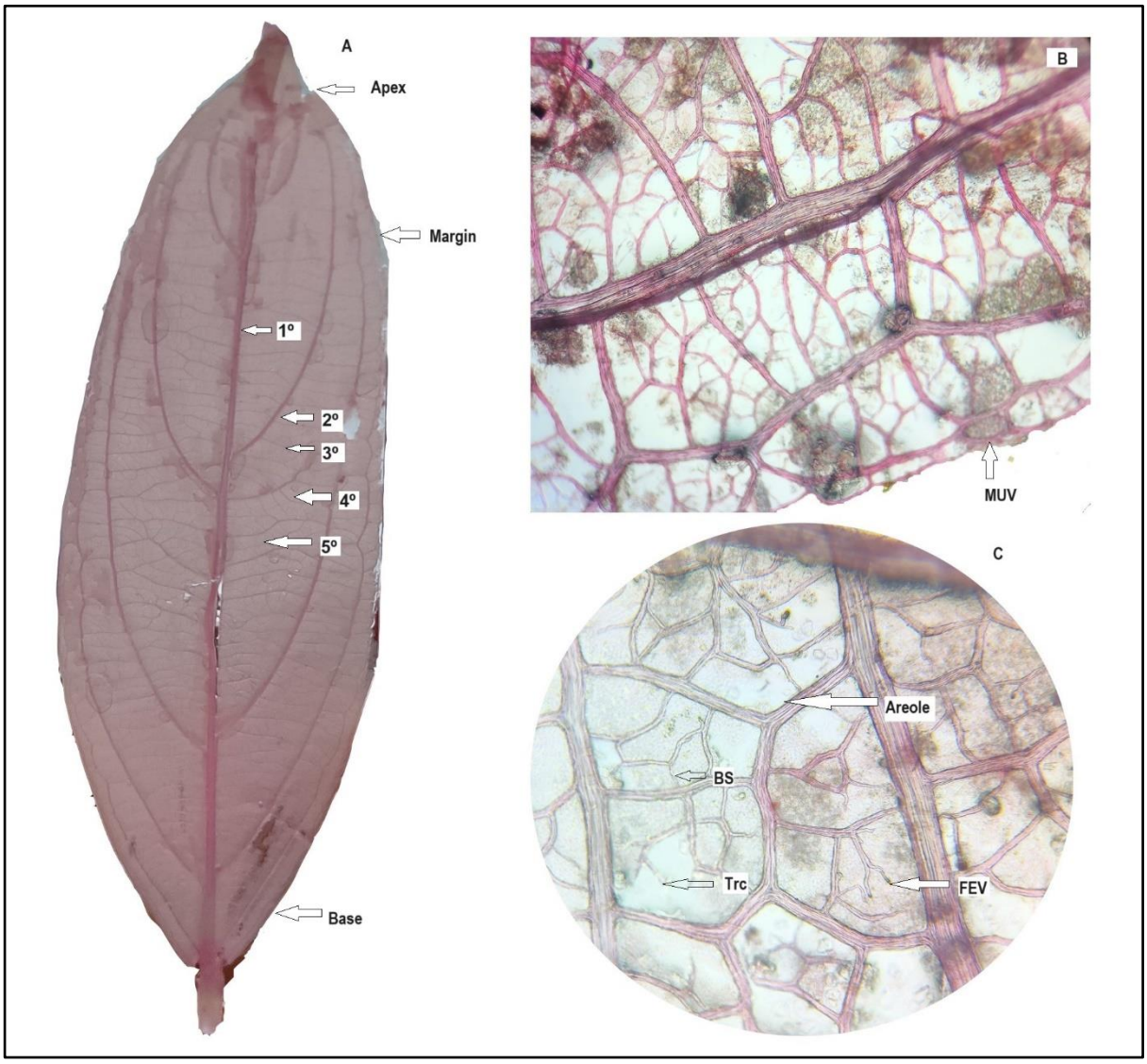

Plate 34. ***Glochidion multiloculare*** var. ***multiloculare*** **A**. Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **B.** Marginal Ultimate Venation (MUV), 40X **C.** Areole, Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc),40X.

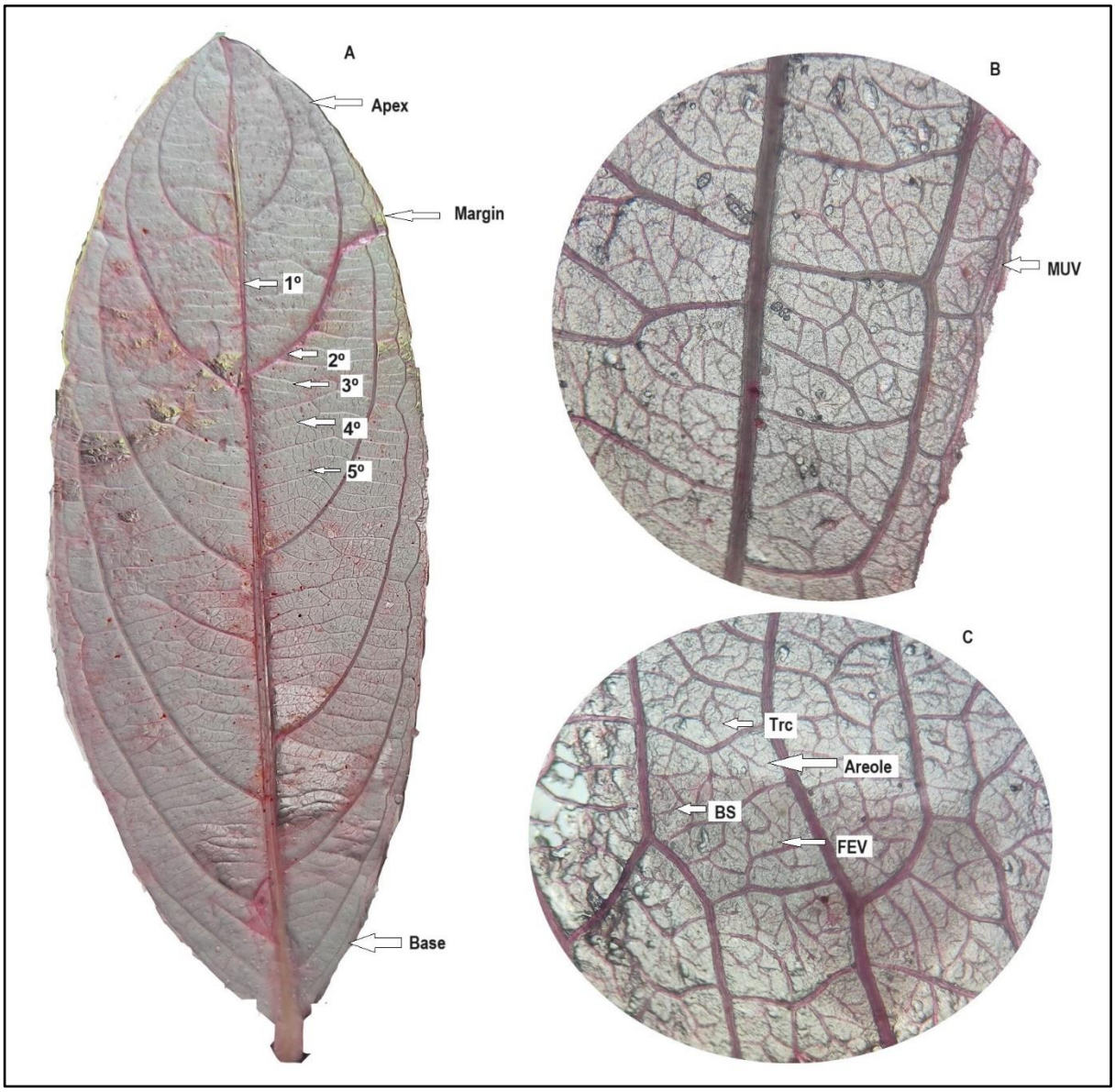

Plate 35. ***Glochidion multiloculare*** var. ***pubescens*** **A**. Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **B.** Marginal Ultimate Venation (MUV), 40X **C.** Areole, Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc), 40X.

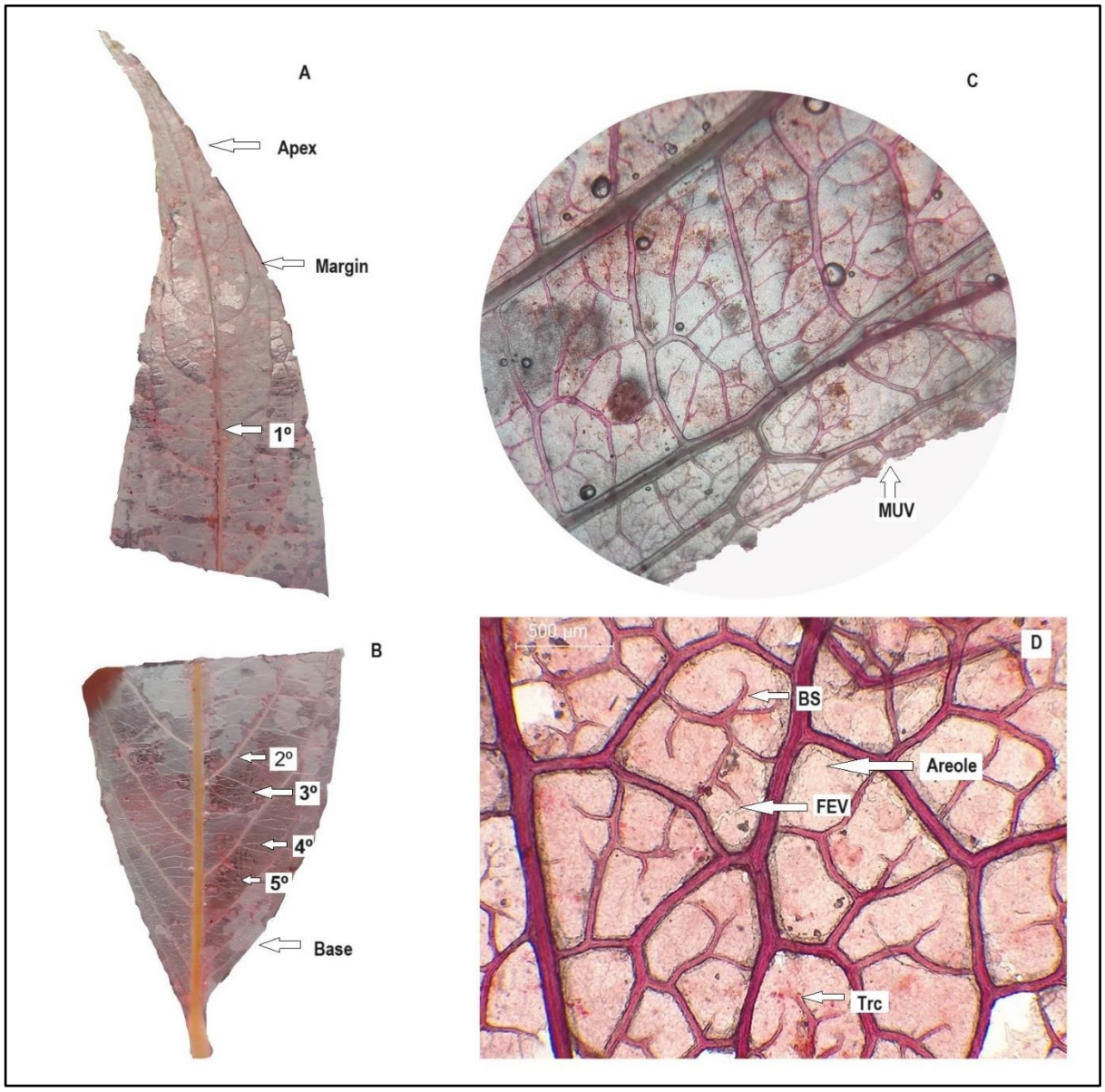

Plate 36. ***Glochidion sphaerogynum*** **A-B.** Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **C.** Marginal Ultimate Venation (MUV), 40X **D.** Areole, Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc), 100X.

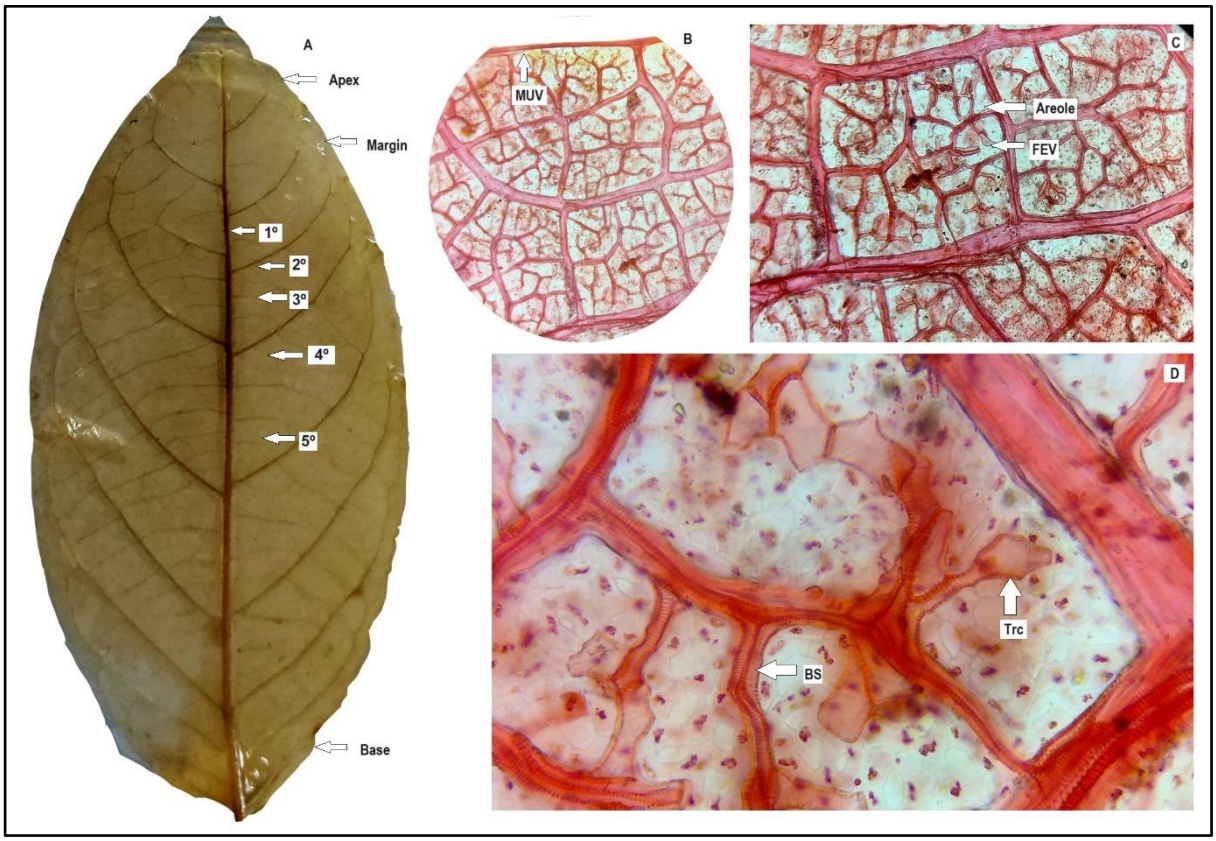

Plate 37. ***Glochidion zeylanicum*** var. ***arborescens*** **A.** Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **B.** Marginal Ultimate Venation (MUV), 40X **C.** Areole, Free Ending Venation (FEV), 40X **D.** Bundle Sheath (BS), Trachieds (Trc), 100X.

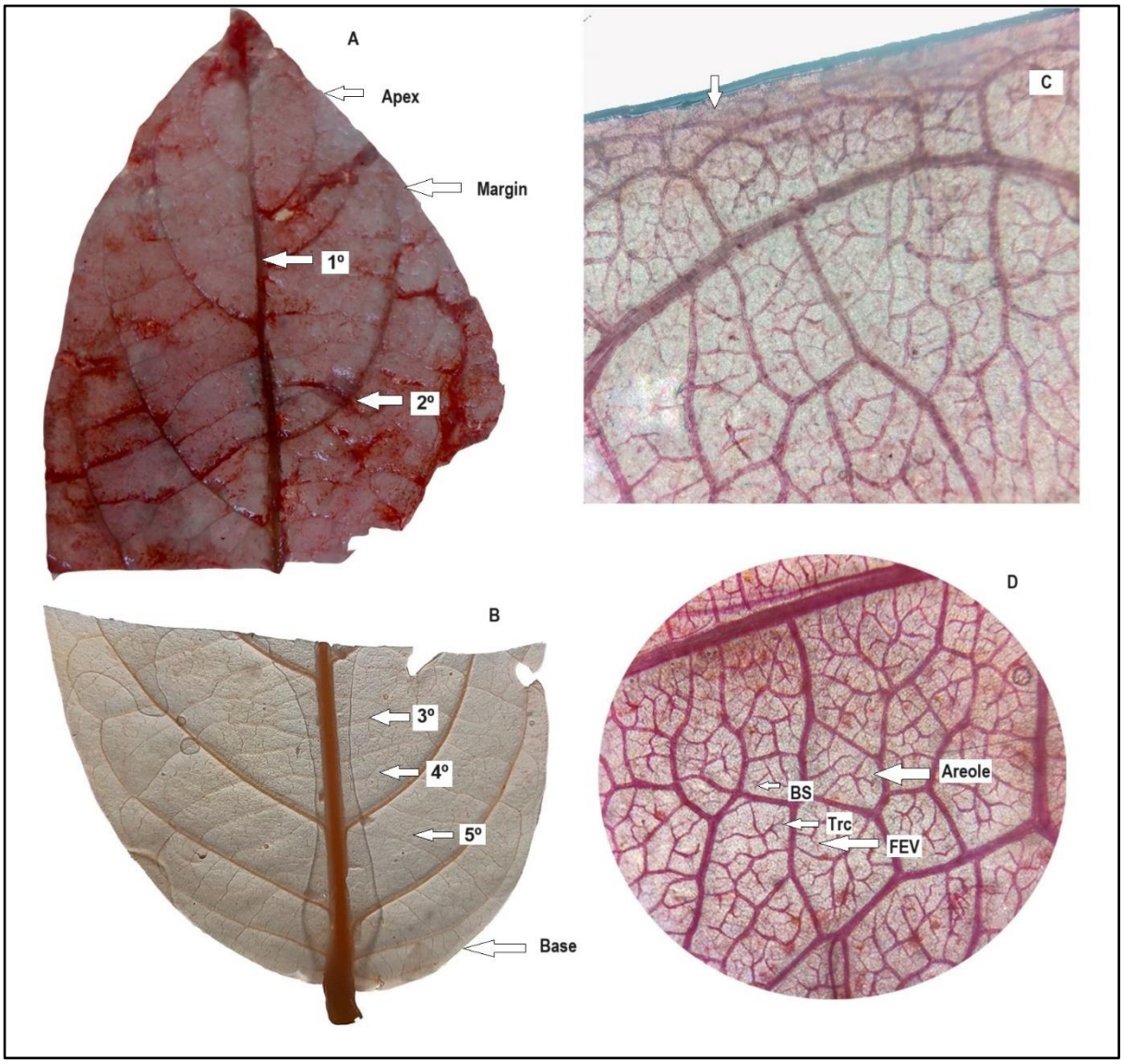

Plate 38. ***Glochidion zeylanicum*** var. ***paucicarpum*** **A-B.** Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **C.** Marginal Ultimate Venation (MUV), 40X **D.** Areole, Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc), 40X.

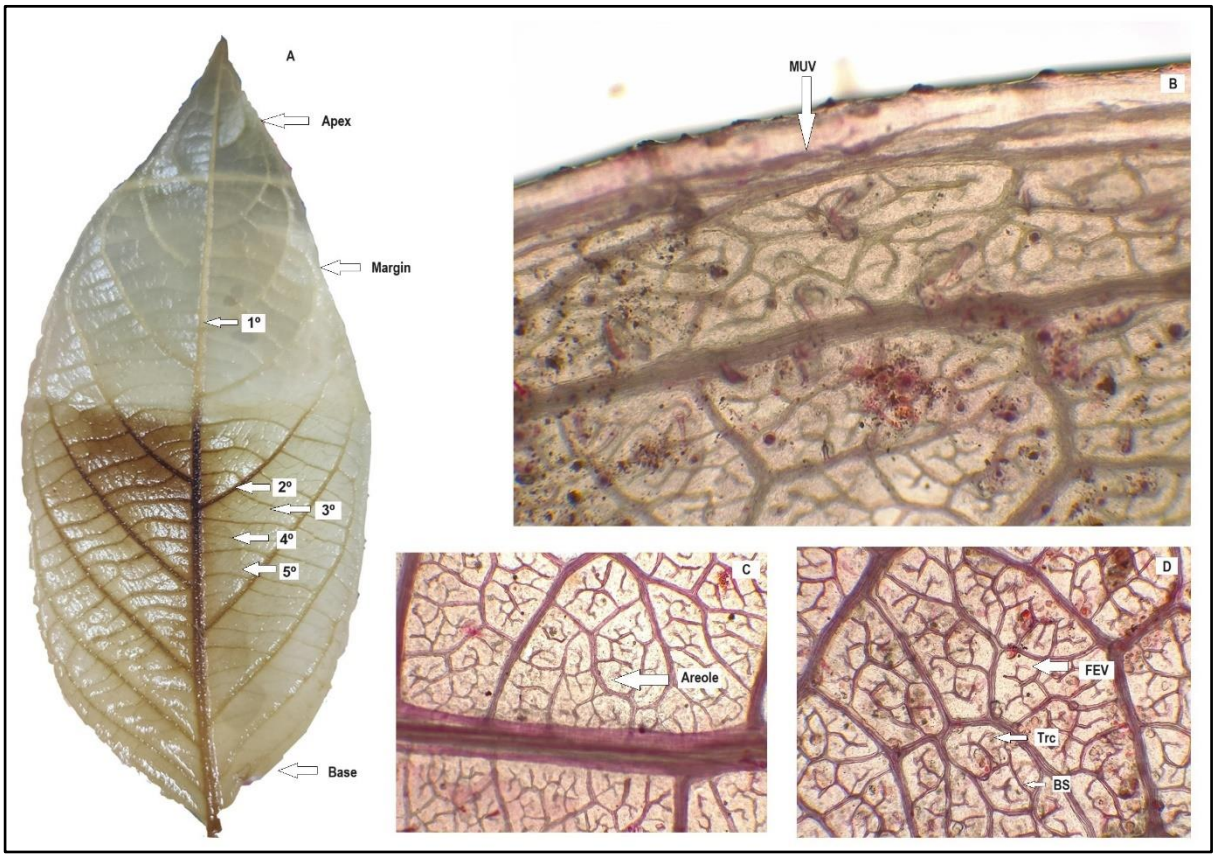

Plate 39. ***Glochidion zeylanicum*** var. ***tomentosum*** **A.** Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **B.** Marginal Ultimate Venation (MUV), 40X **C-D.** Areole, Free Ending Venation (FEV), Bundle Sheath (BS), Tracheids (Trc), 40X.

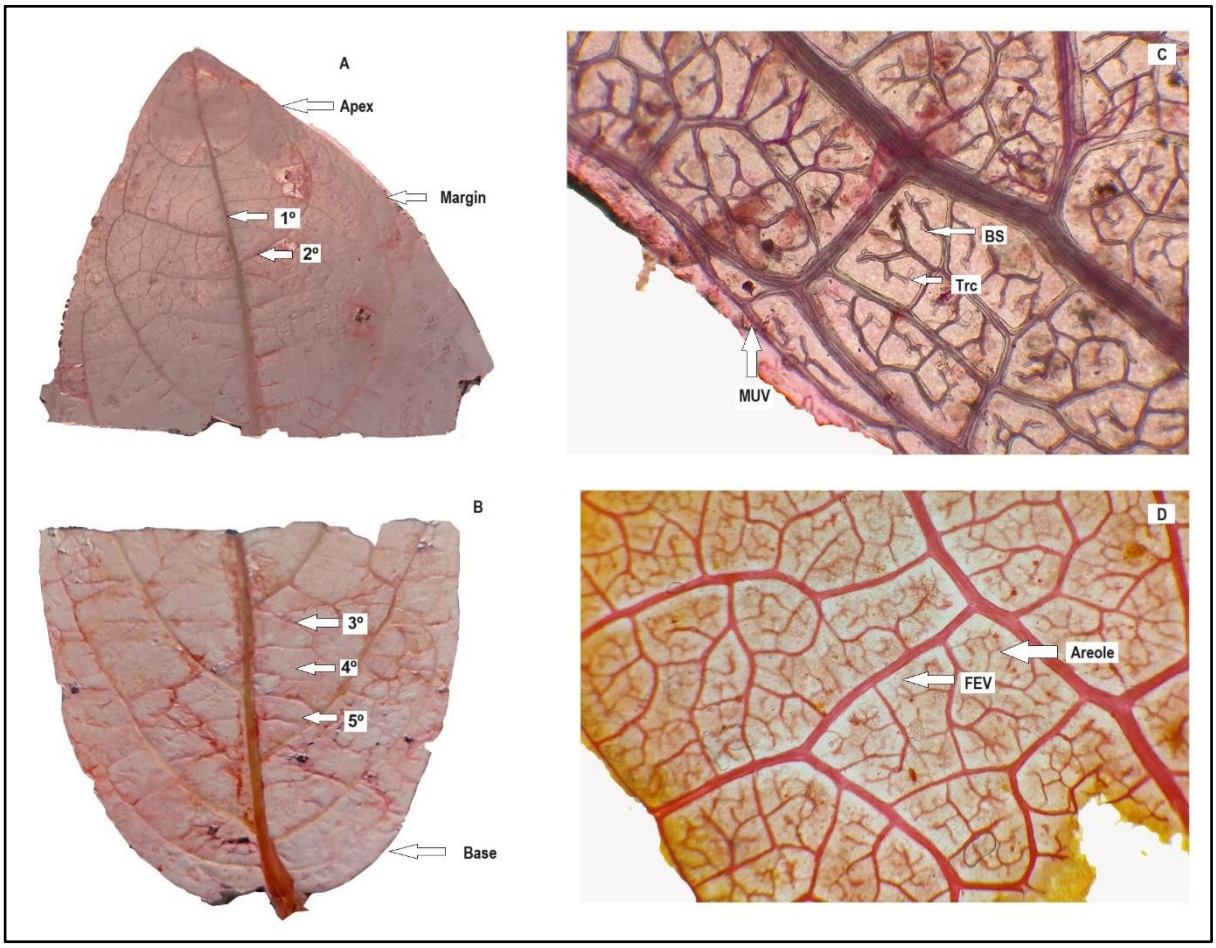

Plate 40. ***Glochidion zeylanicum*** var. ***zeylanicum*** **A-B.** Leaf architecture structure showing apex, margin, midvein or 1° (Primary), 2° (Secondary), 3° (Tertiary), 4° (Quaternary), 5° (Quintenary), Base. **C.** Marginal Ultimate Venation (MUV), Bundle Sheath (BS), Tracheids (Trc), 40X **D.** Areole, Free Ending Venation (FEV), 40X.

4.6. Ethnobotanical Study

An ethnobotanical study was conducted by interrogating local villagers and traditional healers of Assam. Three species are mainly used as medicine to treat various ailments in Assam. Parts used, preparation approach, and customs of those medicinally used species are presented in **Table 2**.

Table 2. Traditional uses of *Glochidion* spp. in Assam

Sl. No.	Name of the species	Parts Used	Mode of preparation	Application	Route of administration
1	*Glochidion ellipticum* Wight	Leaves	Leaves are crushed and make a paste that is applied to the swelling area and also used to treat skin problems.	Body swelling and skin problems	External
		Bark	A small quantity of bark is crushed into a paste and then applied to the swelling part of the body.	Body swelling	External
		Roots	Roots are ground into a paste.	Snakebite	External
2	*G. multiloculare* (Rottler ex Willd.) Voigt	Leaves	A small number of leaves are pulverized and applied.	Fracture and body swelling	External
		Bark	A small quantity of bark is pounded into a paste and applied to wounds.	Skin diseases and wounds (Bajpai et al., 2016)	External
		Roots	Roots are crushed to make a paste and applied in the snake-biting area.	Snakebite	External
3	*G. sphaerogynum* (Mull.Arg.) Kurz	Leaves	Leaves and bark are crushed together and blended with little water.	Skin diseases	External
		Bark	Bark is pulverized and blended with water to make a paste and applied in the inflammation area.	Skin inflammation	External

4.7. Phytochemical Study

A phytochemical study of different parts (leaves, bark, and roots) of *G. ellipticum*, *G. multiloculare,* and *G. sphaerogynum* was carried out. Based on the parts used of the plant species documented throughout the ethnobotanical work of the study area (**Table 2**), both qualitative and quantitative phytochemical studies, antioxidant activities, GC-MS analysis, and assessment of mineral elements were carried out.

4.7.1. Phytochemical screening

Phytochemical screening was tested for the parts used of documented species using the solvent methanol and ethanol. The presence or absence of different phytoconstituents were represented in **Table 3 to Table 5**. During the phytochemical test, the result of methanol extract showed a higher yield than ethanol extract. Also, methanol extract exhibits better antioxidant activities. Therefore, methanol extraction was taken for further phytochemical analysis.

Table 3. Qualitative phytochemical test of *G. ellipticum* leaves, barks, and roots

Phytochemical test	**Leaves**		**Barks**		**Roots**	
	Methanol	Ethanol	Methanol	Ethanol	Methanol	Ethanol
Alkaloid						
1. Dragendorff's test	+	+	+	+	+	+
2. Mayer's test	+	+	+	+	-	+
3. Wagner's test	+	+	+	+	+	+
Reducing sugar (Fehling's test)	+	-	+	+	+	-
Steroid (Salkowski test)	+	-	+	-	+	-
Phlobatannins (HCl test)	+	-	-	-	+	-
Tannins ($FeCl_3$ test)	+	+	+	-	+	+
Flavonoids						
1. $FeCl_3$ test	+	+	+	+	+	+
2. H_2SO_4 test	+	-	+	-	+	-

Terpenoids (Salkowski test)	+	-	+	-	+	+
Triterpenoids (H_2SO_4 test)	+	+	+	+	-	+
Saponin (Foam test)	+	-	+	+	+	-
Glycoside						
1. Keller-Killiani test	-	+	+	-	-	+
2. Borntrager's test	-	-	-	-	-	-
Phenol ($FeCl_3$ test)	+	+	+	+	-	+

Symbol used: + = Presence of test, - = Absence of test

Table 4. Qualitative phytochemical test of *G. multiloculare* leaves, barks, and roots

Phytochemical test	**Leaves**		**Barks**		**Roots**	
	Methanol	Ethanol	Methanol	Ethanol	Methanol	Ethanol
Alkaloid						
1. Dragendorff's test	+	+	+	+	+	+
2. Mayer's test	+	+	+	+	+	+
3. Wagner's test	+	+	+	+	+	+
Reducing sugar (Fehling's test)	+	-	+	+	+	-
Steroid (Salkowski test)	+	+	+	-	-	+
Phlobatannins (HCl test)	+	-	+	+	-	+
Tannins ($FeCl_3$ test)	+	+	+	-	+	+
Flavonoids						
1. $FeCl_3$ test	+	+	-	+	+	+
2. H_2SO_4 test	+	+	+	-	+	-

Terpenoids (Salkowski test)	+	+	+	+	-	+
Triterpenoids (H_2SO_4 test)	+	-	+	-	-	+
Saponin (Foam test)	+	-	+	+	-	-
Glycosides						
1. Keller-Killiani test	+	-	+	-	+	-
2. Borntrager's test	+	-	+	-	+	-
Phenol ($FeCl_3$ test)	+	+	+	+	+	-

Symbol used: + = Presence of test, - = Absence of test

Table 5. Qualitative phytochemical test of *G. sphaerogynum* leaves and barks

Phytochemical test	**Leaves**		**Barks**	
	Methanol	Ethanol	Methanol	Ethanol
Alkaloid				
1. Dragendorff's test	+	+	+	+
2. Mayer's test	+	+	+	+
3. Wagner's test	+	+	+	+
Reducing sugar (Fehling's test)	-	-	-	-
Steroid	+	-	-	-
Phlobatannins (HCl test)	+	-	+	+
Tannins ($FeCl_3$ test)	+	+	+	+
Flavonoids				
1. $FeCl_3$ test	+	+	+	+
2. H_2SO_4 test	-	-	-	-
Terpenoids (Salkowski test)	+	-	+	-
Triterpenoids (H_2SO_4 test)	+	+	+	+
Saponin (Foam test)	+	+	+	+

Glycosides				
1. Keller-Killiani test	-	-	-	-
2. Borntrager's test	+	+	-	-
Phenol ($FeCl_3$ test)	+	+	+	+

Symbol used: + = Presence of test, - = Absence of test

4.7.2. Quantitative phytochemical estimation

The quantitative analysis of total alkaloid, flavonoid, saponin, terpenoid, tannin, and phenolic contents in different parts of plant samples i.e., *G. ellipticum*, *G. multiloculare,* and *G. sphaerogynum* showed a good amount of concentration (**Table 6 to Table 8**). Standard curves for phenolic and tannin contents are represented in **Figure 12** and **Figure 13** respectively.

Total alkaloid content (TAC)

The result of total alkaloid content showed that the highest concentration with 8.12±0.21 % yield in *G. multiloculare* bark followed by the 4.12±0.61 % yield in *G. ellipticum* bark, 3.73±1.00 % yield in *G. sphaerogynum* bark, 3.20±0.10 % yield in *G. multiloculare* roots, 3.20±0.40 % yield in *G. sphaerogynum* leaves, 2.40±0.80 % yield in *G. multiloculare* leaves, 2.40±0.40 % yield in *G. ellipticum* leaves and 1.32±0.61 % yield in *G. ellipticum* roots.

Total flavonoid content (TFC)

The flavonoid content showed that the highest concentration with 8.80±1.44 % yield in *G. ellipticum* leaves followed by the 6.92±1.51 % yield in *G. multiloculare* leaves, 4.67±0.91 % yield in *G. multiloculare* bark, 3.87±0.83 % yield in *G. ellipticum* bark, 1.60±0.34 % yield in *G. multiloculare* roots, 1.47±1.00 % yield in *G. ellipticum* roots, 1.44±0.61 % in *G. sphaerogynum* leaves and 1.24±0.80 % in *G. sphaerogynum* bark.

Total saponin content (TSC)

Total saponin content showed the highest concentration with 18.61±0.31 % yield in *G. multiloculare* leaves, 15.20±0.35 % yield in *G. ellipticum* roots, 13.40±0.42 % yield in *G. multiloculare* bark, 12.93±0.81 % yield in *G. sphaerogynum* bark, 9.60±0.49 % yield in *G. multiloculare* roots, 9.51±0.38 % yield in *G. ellipticum* leaves, 9.26±1.70 % yield in *G. sphaerogynum* leaves, 4.13±0.30 % yield in *G. ellipticum* bark.

Total terpenoid content (TTC)

Total terpenoid content showed the highest concentration with 27.11±0.19 % in *G. ellipticum* leaves, 21.16±0.32 % yield in *G. multiloculare* leaves, 17.60±1.21 % yield in *G. ellipticum* roots, 15.04±0.50 % yield in *G. multiloculare* bark, 13.30±0.26 % yield in *G. ellipticum* bark, 11.40±0.36 % yield in *G. multiloculare* roots, 9.2±0.60 % yield in *G. sphaerogynum* leaves, 8.66±0.76 % yield in *G. sphaerogynum* bark.

Total phenolic content (TPC)

The total phenolic contents of the sample extracts were determined from the linear regression curve of the standard gallic acid (y = 0.0048x + 0.324; R^2 = 0.9983) in **Figure 12**. TPC showed the maximum concentration with 3.180±0.872 mg GAE/g dry extract in *G. ellipticum* bark extract followed by 2.168±0.004 mg GAE/g dry extract in *G. multiloculare* bark extract, 1.416±0.001 mg GAE/g dry extract in *G. multiloculare* root extract, 1.375±0.001 mg GAE/g dry extract in *G. sphaerogynum* leaves extract, 0.708±0.003 mg GAE/g dry extract in *G. ellipticum* leaves extract, 0.233±0.002 mg GAE/g dry extract in *G. ellipticum* root extract, 0.166±0.006 mg GAE/g dry extract in *G. sphaerogynum* bark extract and 0.041±0.001 mg GAE/g dry extract in *G. multiloculare* leaves extract.

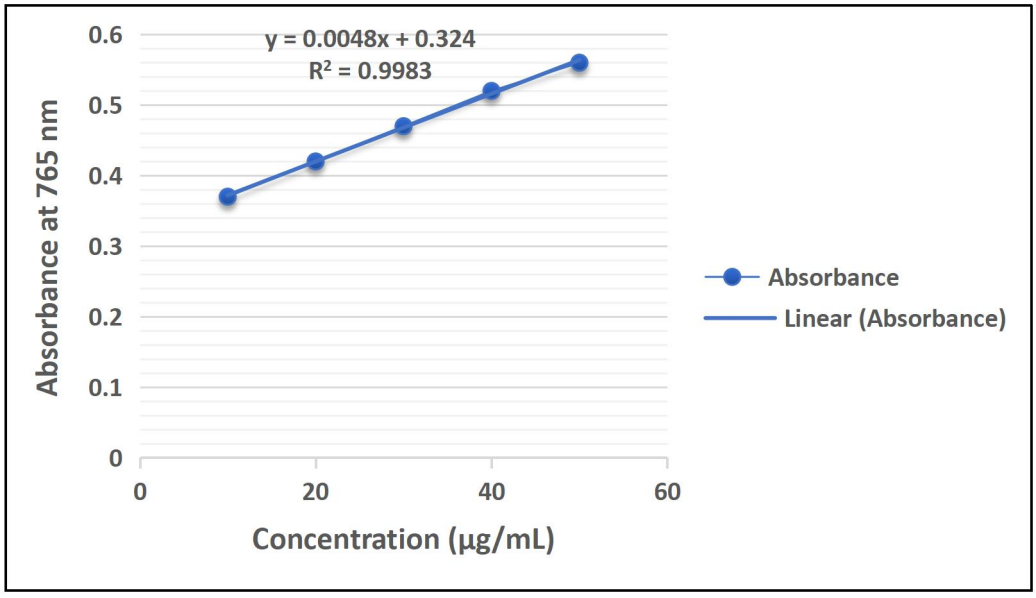

Figure 12. Gallic acid standard curve of estimation of total phenolic content

Total tannin content (TTC)

The total tannin contents (TTC) of the sample extracts were determined from the linear regression curve of the standard tannic acid (y = 0.002x + 0.008; R^2 = 0.9803) in **Figure 13**. Total tannin content showed the highest concentration with 16.917±0.757 mg

TAE/g dry extract in *G. multiloculare* bark extract followed by the 6.921±0.865 mg TAE/g dry extract in *G. sphaerogynum* bark extract, 5.122±0.006 mg TAE/g dry extract in *G. sphaerogynum* leaves extract, 5.115±0.117 mg TAE/g dry extract in *G. ellipticum* root extract, 3.269±0.276 mg TAE/g dry extract in *G. ellipticum* leaves extract, 3.212±0.223 mg TAE/g dry extract in *G. multiloculare* leaves extract, 2.489±0.148 mg TAE/g dry extract in *G. ellipticum* bark extract and 2.186±0.004 mg TAE/g dry extract in *G. multiloculare* root extract.

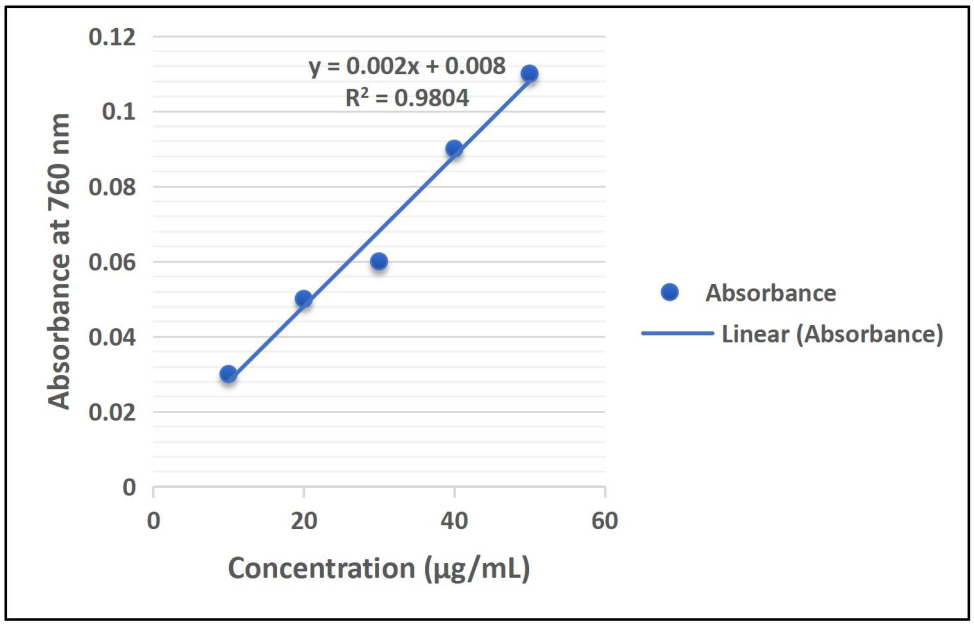

Figure 13. Tannic acid standard curve of estimation of total tannin content

Table 6. Quantitative phytochemical estimation of *G. ellipticum* leaves, barks, and roots

Parameters	Leaves	Barks	Roots
Total alkaloid content (% yield)	2.40±0.40	4.12±0.61	1.32±0.61
Total flavonoid content (% yield)	8.80±1.44	3.87±0.83	1.47±1.00
Total saponin content (% yield)	9.51±0.38	4.13±0.30	15.20±0.35
Total terpenoid content (% yield)	27.11±0.19	13.30±0.26	17.60±1.21
Total phenolic content (mg GAE/g)	0.708±0.003	3.180±0.872	0.233±0.002
Total tannin content	3.269±0.276	2.489±0.148	5.115±0.117

(mg TAE/g)

Table 7. Quantitative phytochemical estimation of *G. multiloculare* leaves, barks, and roots

Parameters	Leaves	Barks	Roots
Total alkaloid content (% yield)	2.40±0.80	8.12±0.21	3.20±0.10
Total flavonoid content (% yield)	6.92±1.51	4.67±0.91	1.60±0.34
Total saponin content (% yield)	18.61±0.31	13.40±0.42	9.60±0.49
Total terpenoid content (% yield)	21.16±0.32	15.04±0.50	11.40±0.36
Total phenolic content (mg GAE/g)	0.041±0.001	2.168±0.004	1.416±0.001
Total tannin content (mg TAE/g)	3.212±0.223	16.917±0.757	2.186±0.004

Table 8. Quantitative phytochemical estimation of *G. sphaerogynum* leaves and barks

Parameters	Leaves	Barks
Total alkaloid content (% yield)	3.20±0.40	3.73±1.00
Total flavonoid content (% yield)	1.44±0.61	1.24±0.80
Total saponin content (% yield)	9.26±1.70	12.93±0.81
Total terpenoid content (% yield)	9.2±0.60	8.66±0.76
Total phenolic content (mg GAE/g)	1.375±0.001	0.166±0.006
Total tannin content (mg TAE/g)	5.122±0.006	6.921±0.865

4.8. In vitro Antioxidant activity

In the present study, antioxidant activities were determined using two commonly used in vitro methods i.e. DPPH free radical scavenging assay and ABTS radical scavenging assay.

4.8.1. DPPH free radical scavenging assay

In the DPPH free radical scavenging assay, the % inhibition of plant extract against concentration was plotted in **Figure 14**. The DPPH free radical scavenging activities in methanol plant extracts and IC_{50} values are presented in **Table 9.** The methanol extracts of all the plant samples exhibited increasing scavenging activities with increasing the concentration of extracts in each plant sample. In the study, the standard ascorbic acid exhibited 32.857±0.751% inhibition at 60 µg/mL and exhibited the IC_{50} value of 34.22 µg/mL. Each sample exhibited different concentration amounts and IC_{50} values (**Table 9**).

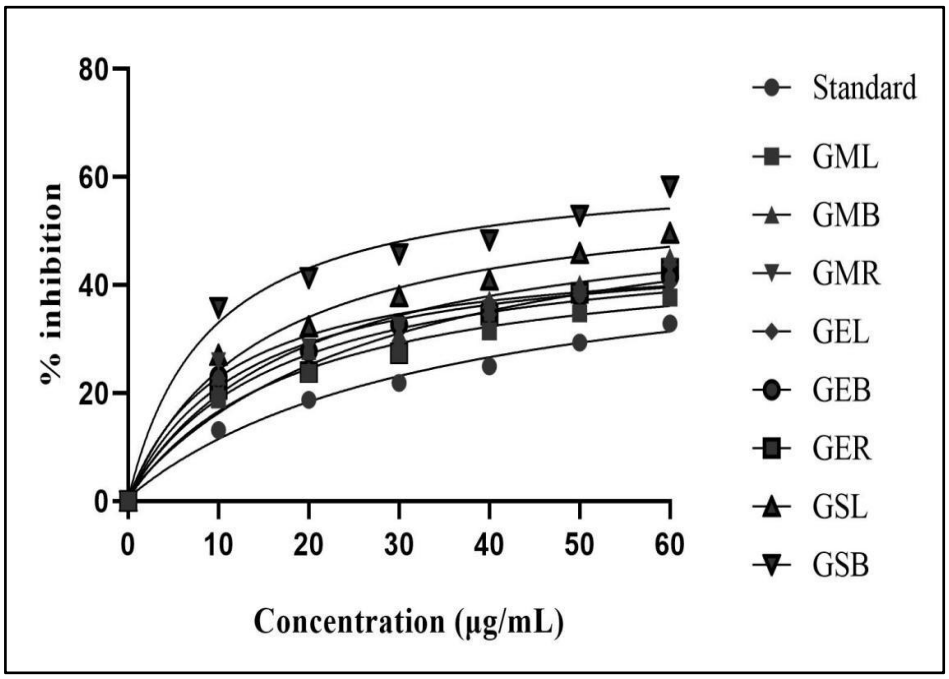

Figure 14. % inhibition of the standard ascorbic acid and different sample extracts against concentration

Table 9. DPPH free radical scavenging assay of different parts of *G. ellipticum*, *G. multiloculare,* and *G. sphaerogynum* extracts

Concentration (µg/mL)	***G. ellipticum***				***G. multiloculare***			***G. sphaerogynum***	
	Ascorbic Acid (% inhibition)	Leaves	Barks	Root	Leaves	Barks	Root	Leaves	Barks
10	13.115 ±0.357	22.709± 0.159	23.057± 0.319	20.758±0 .638	18.808±0 .581	23.022±0 .470	25.844± 0.435	27.028± 0.435	35.840±1 .358
20	18.790 ±0.256	24.102± 0.395	27.725± 0.784	23.858±0 .367	23.649±0 .336	27.795±0 .209	28.456± 0.367	32.251± 0.161	41.309±0 .680
30	21.916 ±0.306	29.606± 0.319	32.531± 0.217	27.307±0 .435	27.342±0 .263	31.033±0 .276	32.496± 0.313	37.896± 0.711	45.732±0 .837
40	24.906 ±0.386	34.517± 0.695	35.667± 0.422	34.412±0 .741	31.382±0 .395	37.234±0 .263	35.631± 0.455	40.926± 0.217	48.345±0 .217
50	29.289 ±0.385	38.139± 0.313	37.896± 0.366	38.557±1 .177	34.795±0 .276	40.159±0 .876	38.209± 0.262	45.802± 0.262	52.803±0 .336
60	32.857 ±0.751	40.159± 0.594	41.413± 0.159	43.050±1 .345	37.687±0 .263	45.175±0 .395	43.399± 1.740	49.599± 1.306	58.306±0 .522
IC_{50} (µg/mL)	34.22	16.74	12.93	22.50	19.17	19.01	10.67	14.45	8.899

4.8.2. ABTS assay

In ABTS assay, the % inhibition of plant extract against concentration was plotted in **Figure 15**. The ABTS scavenging activities in methanol plant extracts and IC_{50} values are given in **Table 10.** The methanol plant extracts exhibited increasing scavenging activities with increasing the concentration of extracts in each plant sample. In the study, the standard ascorbic acid exhibited 62.703±0.181 % inhibition at 60 µg/mL and exhibited the IC_{50} value of 47.61 µg/mL. Each sample exhibited different concentration amounts and IC_{50} values (**Table 10**).

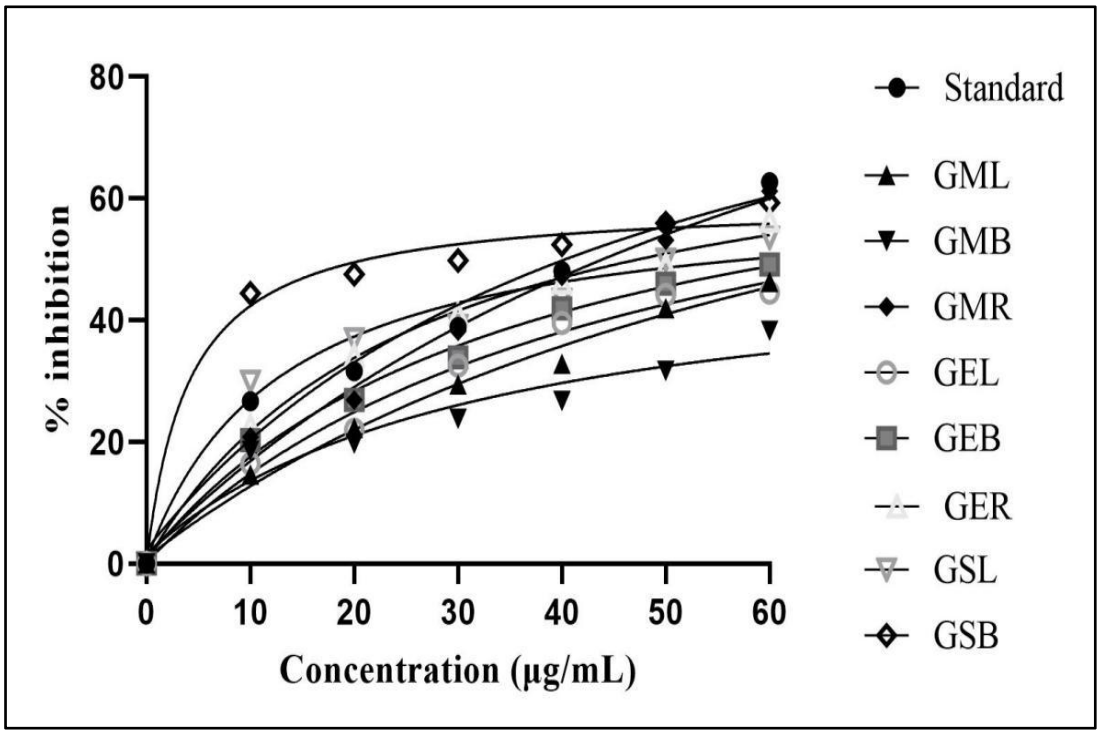

Figure 15. % inhibition of the standard ascorbic acid and different sample extracts against concentration

Table 10. ABTS radical scavenging assay of different parts of *G. ellipticum*, *G. multiloculare,* and *G. sphaerogynum* extracts

Concentration (µg/mL)		***G. ellipticum***			***G. multiloculare***			***G. sphaerogynum***	
	Ascorbic Acid (% inhibition)	Leaves	Barks	Root	Leaves	Barks	Root	Leaves	Barks
10	26.617 ±0.188	16.355± 1.874	20.289± 0.488	22.596±0 .653	14.581±0 .184	18.544±0 .319	20.851± 0.443	29.842± 1.050	44.424±1 .181
20	31.669 ±0.327	22.005± 3.539	26.855± 0.948	34.131±0 .184	22.241±0 .358	19.786±0 .386	26.855± 0.222	36.882± 5.021	47.500±0 .399
30	38.868 ±0.604	32.504± 0.218	33.953± 0.774	40.934±0 .795	29.399±0 .577	23.809±0 .399	38.213± 0.271	39.071± 1.590	49.866±0 .319
40	48.094 ±0.051	39.514± 0.775	41.910± 0.330	46.198±0 .653	32.800±0 .654	26.796±0 .266	47.174± 0.223	43.329± 0.311	52.439±0 .843
50	55.837 ±0.557	44.188± 0.871	45.991± 0.440	49.038±0 .285	41.969±0 .406	31.617±0 .653	53.120± 0.671	49.955± 0.234	55.959±0 .270
60	62.703 ±0.181	44.542± 0.590	49.097± 0.117	56.166±0 .307	46.317±1 .00	38.301±0 .285	61.224± 0.406	53.593± 3.074	59.272±0 .355
IC_{50} (µg/mL)	47.61	45.75	35.60	25.88	75.23	31.81	76.97	12.91	4.059

4.9. GC-MS Analysis

The volatile components present in methanolic extracts of *G. ellipticum*, *G. multiloculare,* and *G. sphaerogynum* are shown in **Figure 16 to Figure 23.** The retention time, molecular weight, molecular formula, and % of peak area were represented in **Table 11 to Table 18**.

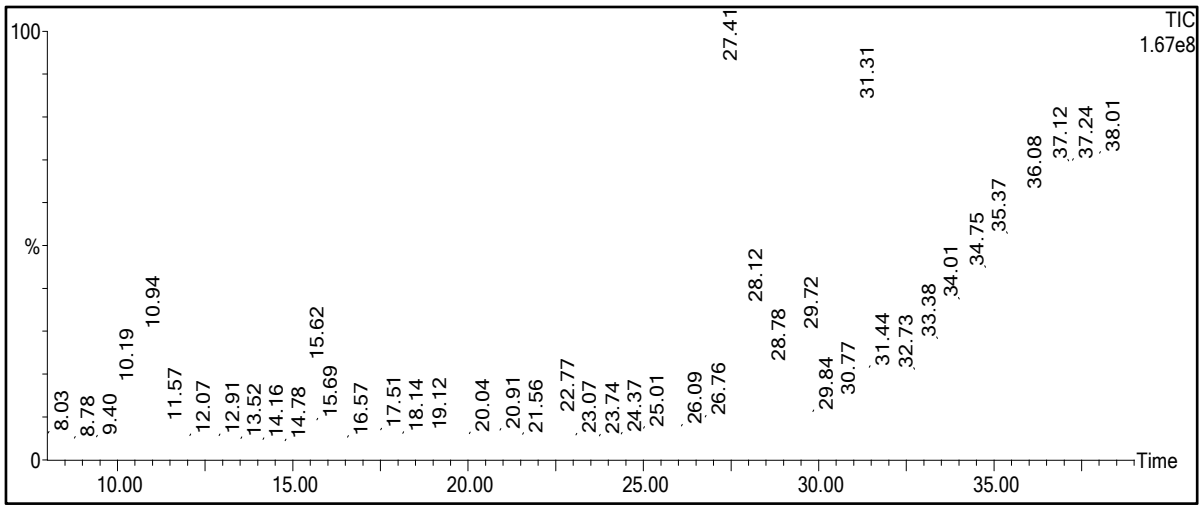

Figure 16. GC-MS chromatogram of methanolic leaf extract of *G. ellipticum*

Table 11. GC-MS data of methanolic leaf extract of *G. ellipticum*

Sl. No.	Retention time	Compound Name	Peak area %	Molecular weight	Molecular Formula
1	10.19	Benzene, 1-Ethyl-2-Methyl-	0.963	120	C_9H_{12}
2	10.94	Mesitylene	1.805	120	C_9H_{12}
3	15.62	Benzofuran, 2,3-Dihydro	3.141	120	C_8H_8O
4	22.77	Neophytadiene	1.197	278	$C_{20}H_{38}$
5	27.41	Phytyl Tetradecanoate	6.4	506	$C_{34}H_{66}O_2$
6	28.12	Z,Z-6,28-Heptatriactontadien-2-One	2.037	530	$C_{37}H_{70}O$
7	28.78	Methyl 11-Methyl-Dodecanoate	1.258	228	$C_{14}H_{28}O_2$
8	29.72	Chlorpyrifos	1.221	349	$C_9H_{11}Cl_3NO_3PS$
9	31.31	Phytyl Palmitate	5.829	534	$C_{36}H_{70}O_2$

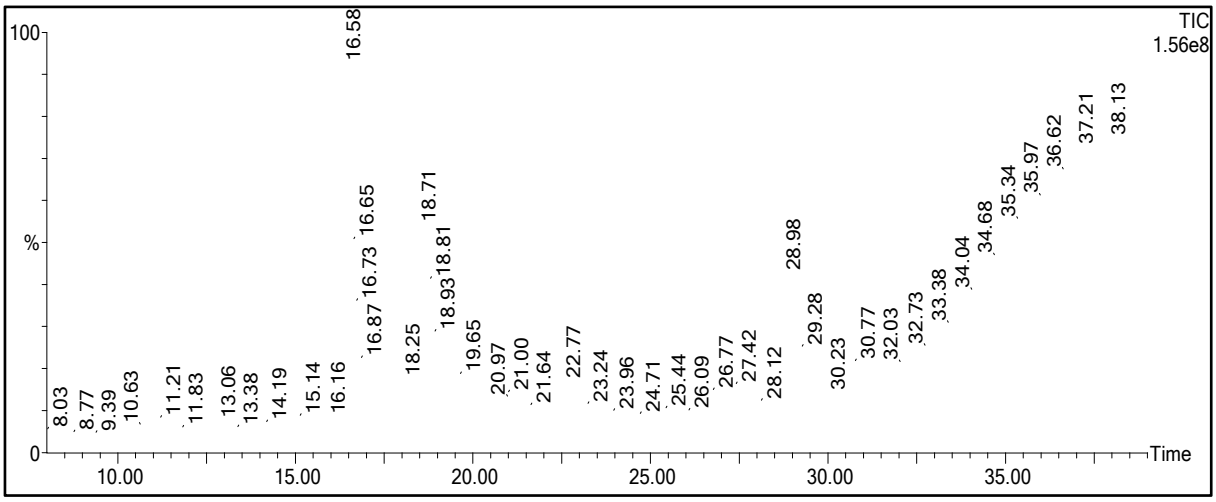

Figure 17. GC-MS chromatogram of methanolic bark extract of *G. ellipticum*

Table 12. GC-MS data of methanolic bark extract of *G. ellipticum*

Sl. No.	Retention time	Compound Name	Peak area %	Molecular weight	Molecular formula
1	16.58	1,2-Benzenediol, 3-Methoxy-	16.625	140	$C_7H_8O_3$
2	18.25	Hentriacontane	2.312	436	$C_{31}H_{64}$
3	18.71	1,2,3-Benzenetriol	12.586	126	$C_6H_6O_3$
4	19.65	12-Bromododecanoic Acid	1.178	278	$Br(CH_2)_{11}CO_2H$
5	21.64	L-(+)-Ascorbic Acid 2,6-Dihexadecanoate	1.175	652	$C_{38}H_{68}O_8$
6	22.77	Piconol	3.227	109	C_6H_7NO
7	28.98	Benzenepropanoic Acid, 3,5-Bis(1,1-Dimethylethyl)-4-Hydroxy-, Methylester	1.089	292	$C_{18}H_{28}O_3$
8	29.28	Eicosanoic acid	1.695	312	$C_{20}H_{40}O_2$
9	30.23	N-Hexadecanoic Acid	0.724	256	$C_{16}H_{32}O_2$
10	30.77	Octadecanoic Acid	1.475	298	$C_{18}H_{36}O_2$

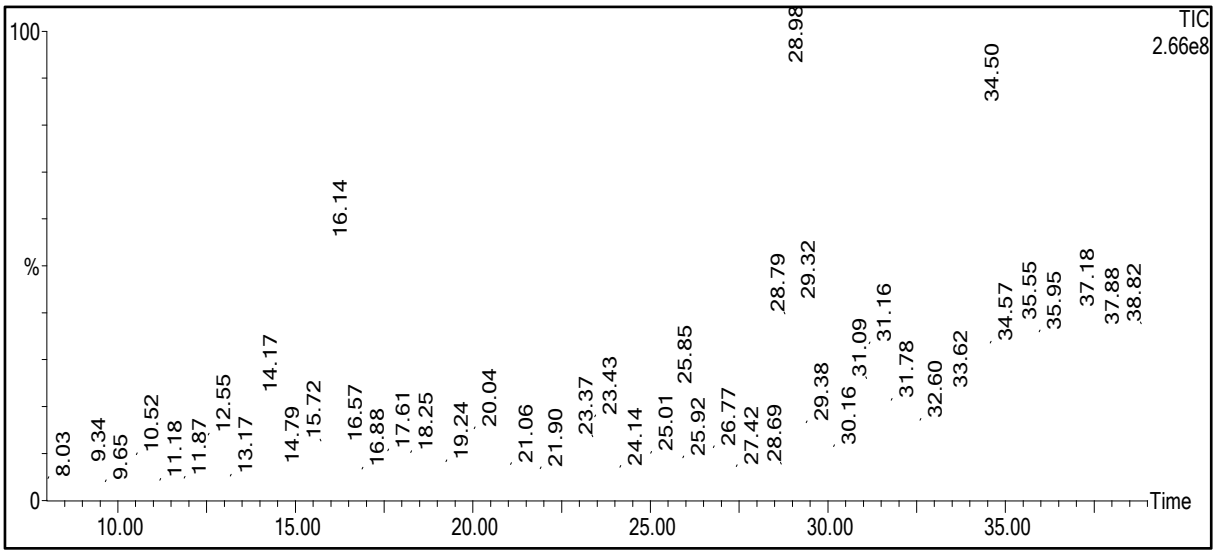

Figure 18. GC-MS chromatogram of methanolic root extract of *G. ellipticum*

Table 13. GC-MS data of methanolic root extract of *G. ellipticum*

Sl. No.	Retention time	Compound Name	Peak area %	Molecular weight	Molecular Formula
1	10.52	Lomustine	1.205	233	$C_9H_{16}CIN_3O_2$
2	12.55	Thymine	1.222	126	$C_5H_6N_2O_2$
3	14.17	Octanoic Acid, 2-Hexyl-	1.188	228	$C_{14}H_{28}O_2$
4	15.72	3-Methyl-2-(2-Oxopropyl) Furan	1.217	138	$C_8H_{10}O_2$
5	16.14	2-Coumaranone	3.269	134	$C_8H_6O_2$
6	17.61	Succinic Acid, 8-Chlorooctyl 2-Naphthyl Ester	1.199	390	$C_{22}H_{27}CIO_4$
7	18.25	Z,Z-6,28-Heptatriactontadien-2-One	1.192	530	$C_{37}H_{70}O$
8	23.43	Metoprolol, 2TMS Derivative	0.932	411	$C_{21}H_{41}NO_3Si_2$
9	25.85	(E)-4-(3-Hydroxyprop-1-En-1-Yl)-2-Methoxyphenol	1.735	180	$C_{10}H_{12}O_3$
10	26.77	Benzoic Acid, 2-Hydroxy-6-Methyl-, Methyl Ester	0.956	166	$C_9H_{10}O_3$
11	28.79	N-Propyl 11-Octadecenoate	2.895	324	$C_{21}H_{40}O_2$
12	28.98	Tetradecanoic Acid, 10,13-Dimethyl-, Methyl Ester	4.388	270	$C_{17}H_{34}O_2$
13	29.32	N-Hexadecanoic Acid	1.673	256	$C_{16}H_{32}O_2$

14	31.16	Eicosanoic acid	1.102	312	$C_{20}H_{40}O_2$
15	34.50	Cyclobarbital	3.506	236	$C_{12}H_{16}N_2O_3$
16	35.55	L-(+)-Ascorbic Acid 2,6-Dihexadecanoate	1.221	652	$C_{38}H_{68}O_8$
17	37.18	1-Nonylcycloheptane	0.885	266	$C_{16}H_{32}$

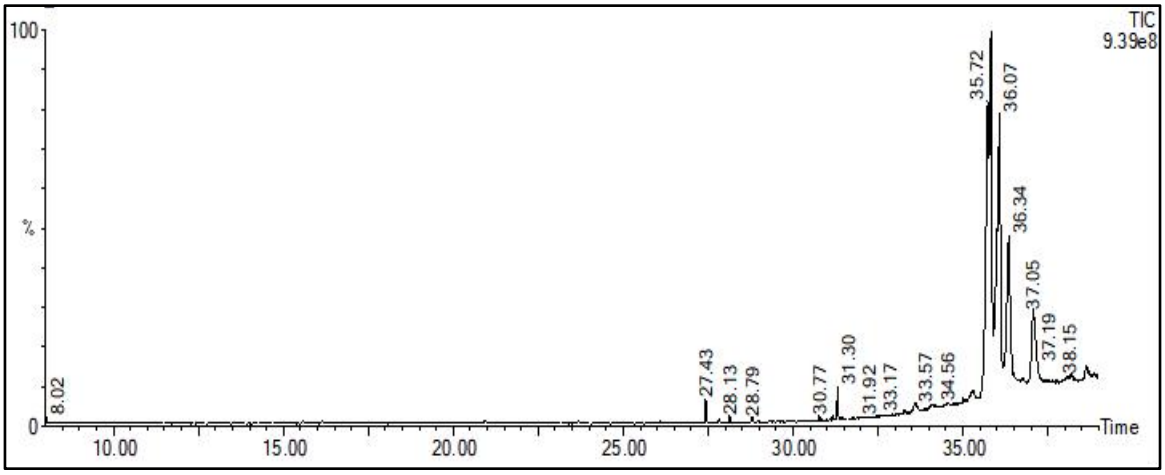

Figure 19. GC-MS chromatogram of methanolic leaf extract of *G. multiloculare*

Table 14. GC-MS data of methanolic leaf extract of *G. multiloculare*

Sl. No.	Retention time	Compound name	Peak area %	Molecular weight	Molecular formula
1	27.43	Neophytadiene	0.567	278	$C_{20}H_{38}$
2	31.30	Phytol	0.683	296	$C_{20}H_{40}O$
3	31.92	Citronellol	1.013	156	$C_{10}H_{20}O$
4	33.57	Z,Z-6,28-Heptatriactontadien-2-One	0.921	530	$C_{37}H_{70}O$
5	35.72	1-Methylene-2B-Hydroxymethyl-3,3-Dimethyl-4B-(3-Methylbut-2-Enyl)-cyclohexane	15.197	222	$C_{15}H_{26}O$
6	36.07	Lup-20(29)-En-3-One	16.81	424	$C_{30}H_{48}O$
7	36.34	Lupeol	10.3	426	$C_{30}H_{50}O$
8	37.05	2R-Acetoxymethyl-1,3,3-Trimethyl-4T-(3-Methyl-2-Buten-1-YL)-1T-Cyclohexanol	7.745	282	$C_{17}H_{30}O_3$

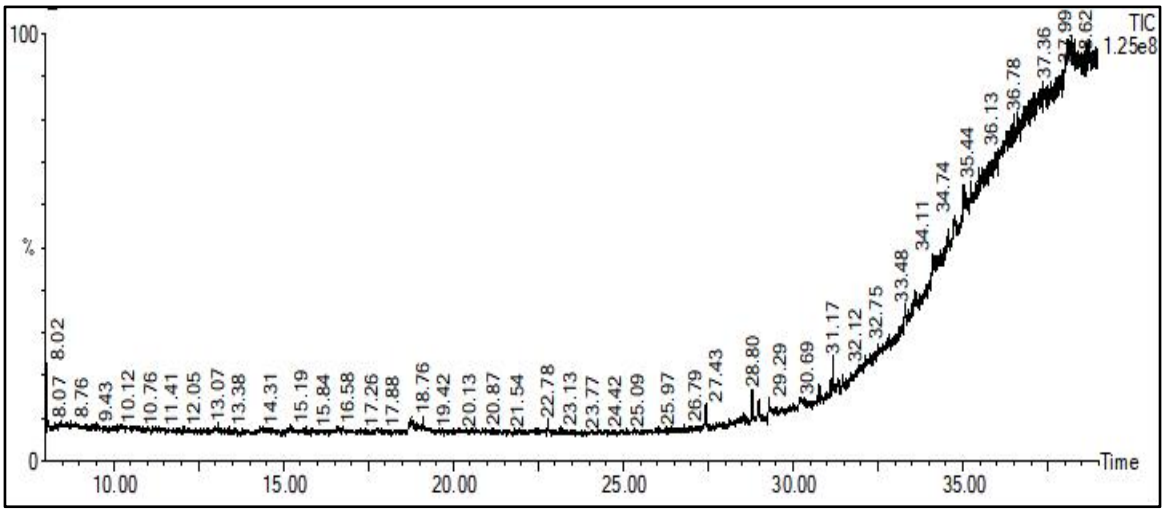

Figure 20. GC-MS chromatogram of methanolic bark extract of *G. multiloculare*

Table 15. GC-MS data of methanolic bark extract of *G. multiloculare*

Sl. No.	Retention time	Compound Name	Peak area %	Molecular weight	Molecular Formula
1	22.78	3-Methylpentatriacontane	0.283	506	$C_{36}H_{74}$
2	23.13	Docosanal	0.270	324	$C_{22}H_{44}O$
3	24.42	3-Methyl-2-(2-Oxopropyl) Furan	0.231	138	$C_8H_{10}O_2$
4	27.43	Z,Z-6,28-Heptatriactontadien-2-One	0.278	530	$C_{37}H_{70}O$
5	28.80	Heptacosanoic Acid, 25-Methyl-, Methyl Ester	0.247	438	$C_{29}H_{58}O_2$
6	29.29	Pentadecanoic Acid, 14-Bromo	0.323	320	$C_{15}H_{29}BrO_2$
7	31.17	Oleic acid	0.242	282	$C_{18}H_{34}O_2$
8	35.44	Octasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11,13,13,15,15-Hexadecamethyl-	0.301	578	$C_{16}H_{50}O_7Si_8$
9	37.36	Tetradecanal	0.226	212	$C_{14}H_{28}O$

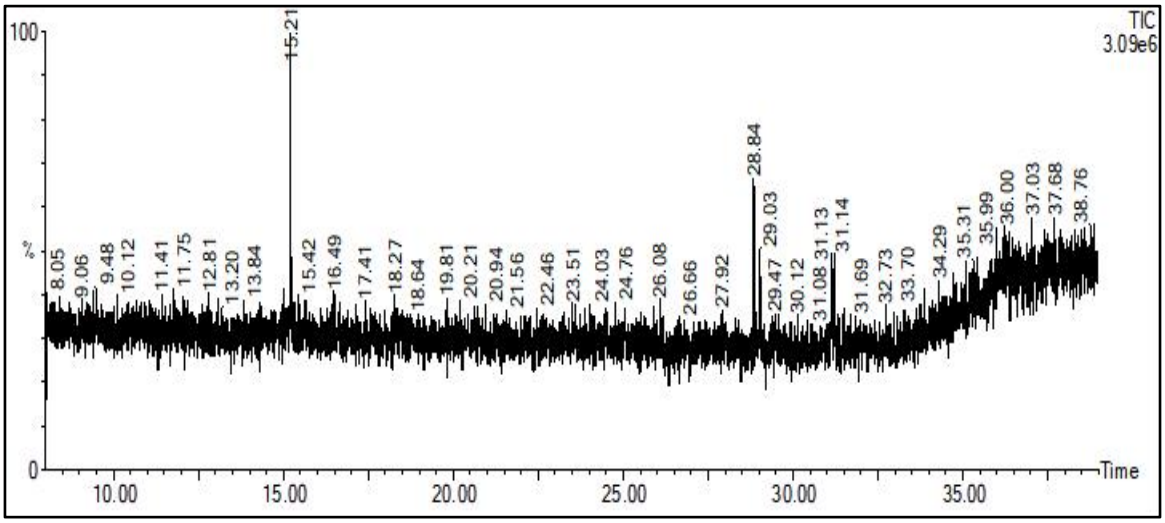

Figure 21. GC-MS chromatogram of methanolic root extract of *G. multiloculare*

Table 16. GC-MS data of methanolic root extract of *G. multiloculare*

Sl. No.	Retention time	Compound Name	Peak area %	Molecular weight	Molecular Formula
1	10.12	Propanoic Acid, 2,2-Dimethyl-, 2-Ethylhexyl Ester	0.289	214	$C_7H_{14}O_2$
2	15.21	Octane, 2,2,6-Trimethyl-	0.936	156	$C_{11}H_{24}$
3	18.27	Undecanoic Acid, 11-Bromo-, Methyl Ester	0.337	278	$C_{12}H_{23}O_2Br$
4	19.81	Hentriacontane	0.488	436	$C_{31}H_{64}$
5	23.51	Sulfurous Acid, Butyl 2-Ethylhexyl Ester	0.294	250	$C_{12}H_{26}O_3S$
6	28.84	2-Methylheptanoic Acid	0.308	144	$C_8H_{16}O_2$
7	29.03	Tridecanoic Acid, 12-Methyl-, Methyl Ester	0.297	242	$C_{15}H_{30}O_2$
8	31.14	9,12-Hexadecadienoic Acid, Methyl Ester	0.298	266	$C_{17}H_{30}O_2$
9	31.69	Methyl 11,12-Tetradecadienoate	0.293	238	$C_{15}H_{26}O_2$

10	32.73	4-Dodecanol	0.459	186	$C_{12}H_{26}O$
11	37.03	7-Octynoic Acid, Methyl Ester	0.531	154	$C_9H_{16}O_2$

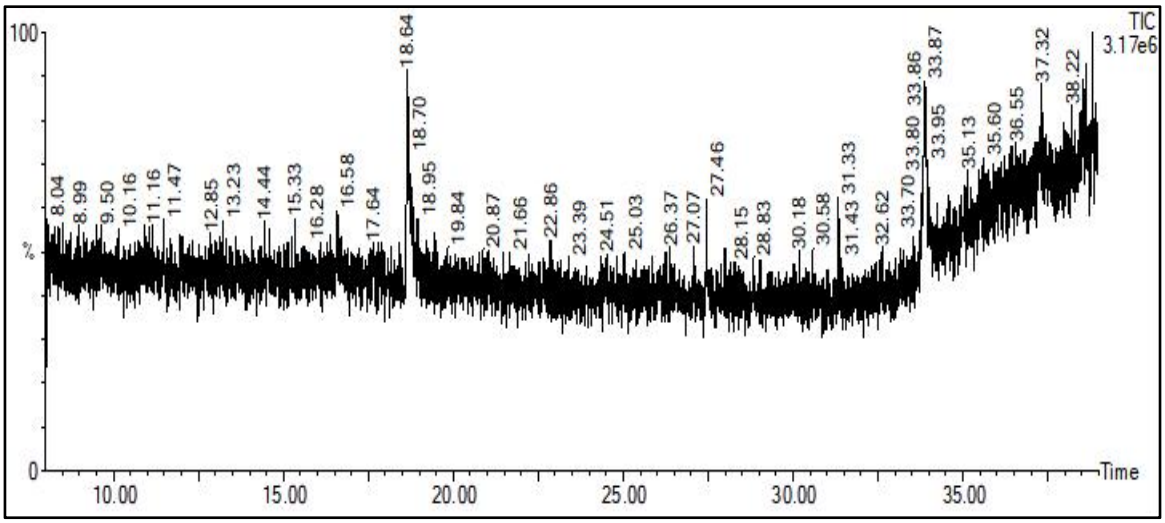

Figure 22. GC-MS chromatogram of methanolic leaf extract of *G. sphaerogynum*

Table 17. GC-MS data of methanolic leaf extract of *G. sphaerogynum*

Sl. No.	Retention time	Compound name	Peak area%	Molecular weight	Molecular formula
1	18.64	1,2,3-Benzenetriol	1.625	126	$C_6H_6O_3$
2	22.86	5-Acetoxymethyl-2-Furaldehyde	0.514	168	$C_8H_8O_4$
3	26.37	3-Cyclopentyl-1-Propanol	0.580	128	$C_8H_{16}O$
4	27.46	Fumaric acid, Heptyl 3-Methylbut-3-Enyl Ester	0.832	282	$C_{15}H_{26}O_4$
5	31.33	2,2-Dimethyl-Propyl 2,2-Dimethyl-Propane-Thiosulfinate	0.729	222	$C_{10}H_{22}OS_2$
6	33.87	Trifluoromethyl T-Butyl Disulfide	0.880	190	$C_5H_9F_3S_2$
7	35.13	Oxalic Acid, Ethyl Neopentyl Ester	0.653	188	$C_9H_{16}O_4$
8	37.32	Anthracene, 9-Ethyl-9, 10-Dihydro-10-Trimethylsilyl-	0.724	280	$C_{19}H_{24}Si$
9	38.22	Heptalene, 7, 7-Dihydro-6,6-Bis (Trimethylsilyl)Methyl-	0.372	354	$C_{22}H_{34}Si_2$

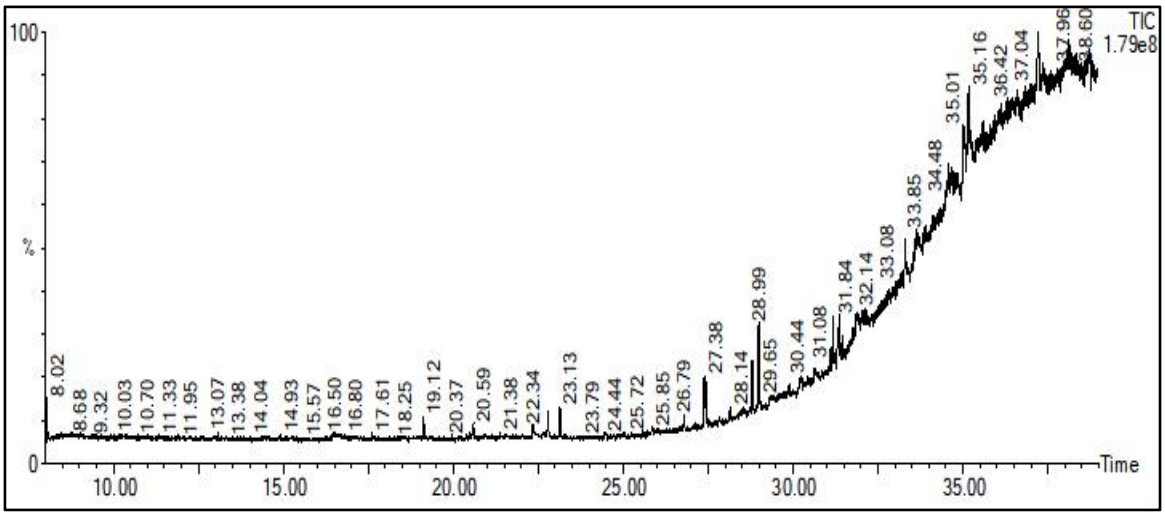

Figure 23. GC-MS chromatogram of methanolic bark extract of *G. sphaerogynum*

Table 18. GC-MS data of methanolic bark extract of *G. sphaerogynum*

Sl. No.	Retention time	Compound Name	Peak area%	Molecular weight	Molecular Formula
1	19.12	Hentriacontane	0.249	436	$C_{31}H_{64}$
2	20.59	Xanthosine	0.247	284	$C_{10}H_{12}N_4O_6$
3	23.13	Fluorene	0.473	166	$C_{13}H_{10}$
4	27.38	Phenanthrene	0.608	178	$C_{14}H_{10}$
5	28.14	Neophytadiene	0.229	530	$C_{20}H_{38}$
6	28.99	Benzenepropanoic Acid, 3,5-Bis(1,1-Dimethylethyl)-4-Hydroxy-, Methyl	1.091	292	$C_{18}H_{28}O_3$
7	31.84	2,6,10,14-Tetramethyl-7-(3-Methylpent-4-Enylidene) Pentadecane	0.468	348	$C_{25}H_{48}$
8	33.85	Z,Z-6,28-Heptatriactontadien-2-One	0.751	530	$C_{37}H_{70}O$
9	35.16	1,1,6-Trimethyl-3-Methylene-2-(3,6,10,13,14-Pentamethyl-3-Ethenyl-Pentadec-4-enyl) cyclohexane	2.263	442	$C_{32}H_{58}$
10	37.96	Methyl 2-Hydroxy-Eicosanoate	0.275	342	$C_{21}H_{42}O_3$

4.10. Assessment of mineral contents

The concentration of different mineral elements has been analysed in the parts used of documented species using AAS and the outcomes of the data are represented in **Table 19 to Table 21.**

Table 19. Mineral determination of *G. ellipticum* leaves, barks, and roots

Parameters	**Results in ppm**		
	Leaves	Barks	Roots
Na	11.269±0.061	10.244±0.017	9.880±0.014
K	0.173±0.003	0.097±0.002	0.136±0.009
Ca	25.792±0.085	42.437±0.013	33.663±0.034
Mg	3.444±0.001	3.444±0.002	3.474±0.076
Fe	3.838±0.029	2.584±0.004	10.651±0.344
Cu	0.273±0.005	0.159±0.002	0.249±0.015
Zn	0.526±0.005	0.479±0.026	1.076±0.064
Mn	0.601±0.001	BDL	BDL
Cr	0.260±0.009	0.164±0.001	0.152±0.003
Pb	0.729±0.007	0.557±0.029	0.776±0.004
Cd	BDL	BDL	BDL

Abbreviation used: BDL= Below Detection Level

Table 20. Mineral determination of *G. multiloculare* leaves, barks, and roots

Parameters	**Results in ppm**		
	Leaves	Barks	Roots
Na	11.415±0.283	10.619±0.055	11.081±0.036
K	0.731±0.243	1.144±0.010	0.253±0.001
Ca	14.571±0.352	34.043±0.066	18.649±0.214
Mg	3.287±0.001	3.384±0.003	3.416±0.013
Fe	4.165±0.134	5.724±0.001	9.226±0.008
Cu	0.344±0.005	0.142±0.003	0.173±0.003
Zn	0.541±0.041	0.536±0.008	0.585±0.006
Mn	1.620±0.168	BDL	BDL

Cr	0.160±0.018	0.197±0.001	0.209±0.004
Pb	BDL	0.135±0.001	0.615±0.004
Cd	0.012±0.001	BDL	BDL

Abbreviation used: BDL= Below detection level

Table 21. Mineral determination of *G. sphaerogynum* leaves and barks

Parameters	**Results in ppm**	
	Leaves	Barks
Na	0.001±0.001	10.552±0.343
K	0.452±0.026	7.230±0.086
Ca	8.650±0.073	8.973±0.310
Mg	3.436±0.007	3.379±0.167
Fe	1.873±0.047	4.026±0.076
Cu	0.306±0.002	0.487±0.030
Zn	1.413±0.029	2.721±0.222
Mn	8.629±0.053	3.367±0.179
Cr	0.137±0.029	0.167±0.011
Pb	0.121±0.006	0.162±0.016
Cd	0.013±0.001	0.009±0.002