



A new species of *Mussaenda* (Rubiaceae) from the southern extent of the Western Ghats Mountain Range, India

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ABSTRACT: *Mussaenda conferta*, a new monomorphic species from the southern extent of India's Western Ghats Mountain range, is described and illustrated. The new species is morphologically similar to *Mussaenda hirsutissima* but distinct by its growth form, shape and size of the stipules, calycophylls and fruits. SEM images of the pollen and seeds of the new species are provided here showing (3–)4-colporate grains and the seeds with tubercular thickenings in inner periclinal and anticlinal walls.

KEY WORDS: Kanyakumari Wildlife Sanctuary, *Mussaenda conferta*, *Mussaenda hirsutissima*, pollen, SEM.

INTRODUCTION

The genus *Mussaenda* L. comprises about 183 species mainly distributed in the Old-World tropics and Australia (POWO, 2022). The newly circumscribed *Mussaenda sensu stricto* (s.s.) by Alejandro *et al.*, (2005) using a multi-marker phylogenetic framework with morphological characters belonging to Afro-Asian clade can easily be diagnosed by having smaller flowers 3–5(–8) cm long, with reduplicate-valvate aestivation. Gangopadhyay *et al.* (2020) recorded 17 species of *Mussaenda* with eight endemic species from different phytogeographical zones in India. The present study area, the Western Ghats of India harbours five species of *Mussaenda*, among them, four are endemic (Singh *et al.*, 2015), namely *Mussaenda glabrata* (Hook.f.) Hutch. ex Gamble, *M. hirsutissima* (Hook.f.) Hutch. ex Gamble, *M. laxa* (Hook.f.) Hutch. ex Gamble and *M. tomentosa* Wall. ex G. Don.

During one of the botanical explorations conducted in the Kanyakumari Wildlife Sanctuary located at the southernmost tip of the Western Ghats, the authors encountered a *Mussaenda* specimen growing in tropical montane grasslands. The specimen is similar to *M. hirsutissima* in having dense hairs on young leaves and branchlets, sessile or subsessile leaves, and long ribbon-like unstriated hairs at the corolla throat. However, examination of fresh flowering and fruiting materials gathered from the field, as well as herbarium specimens (BSI, CAL, KFRI, MH, PBL, TBGT and XCH; digital images from BM, E, G, GDC, GH, GOET, K, L and P), and a review of the relevant literature (Hooker, 1882; Gamble, 1921; Ridley, 1923; Jayaweera, 1963; Ridsdale, 1998; Puff *et al.*, 2005; Shimpale *et al.*, 2009; Chen and Taylor, 2011; Alejandro *et al.*, 2016; Duan *et al.*, 2019; Gangopadhyay *et al.*, 2020) revealed that these Kanyakumari Wildlife Sanctuary *Mussaenda* specimens did not match with any of the known species of the genus from India. Therefore, it is described and illustrated as a

new species and compared with the closely related species *M. hirsutissima* (Table 1, Fig. S1). A key to all *Mussaenda* taxa occurring in India is also provided.

MATERIAL AND METHODS

Plant specimens examined in this study were collected during various botanical trips conducted from 2020 to 2022. Measurements provided in the description are based on mature living plants. Floral characteristics were described based on direct observation using a stereoscopic microscope (Olympus 01C). Scanning Electron Microscope (Evo M 18, Carl Zeiss) was used to study the micromorphology of pollen and seed. Pollen and seed samples obtained from flowers and mature fruits in the field were preserved in FAA (formalin-acetic acid-alcohol solution) and gradually dehydrated. After air drying, the samples were mounted on a stub and coated with a thin layer of gold-palladium mixture using the Mini Sputter Coater (SC7620, Emitech) and examined under the SEM. Palynological terminology follows Erdtman (1952) and Punt *et al.* (1994). A preliminary conservation assessment following the category and criteria given in IUCN (2022) was attempted.

TAXONOMIC TREATMENT

Mussaenda conferta Sujana & Vadhyar, *sp. nov.*

Figs. 1 & 2

Type: India, Tamil Nadu, Kanyakumari district, Kanyakumari Wildlife Sanctuary, Balamore Forest Beat, Muthukuzhivayal, 08°28'50.4" N, 77°23'16.7" E, 1308 m, 21 Feb 2020, Sujana K. A. & Rakesh G. Vadhyar 147531 (Holotype MH [MH00003574]; Isotype CAL).

Mussaenda conferta is similar to *M. hirsutissima* but can be distinguished by its erect shrubby growth form (versus climbing in *M. hirsutissima*), 5–7 mm long shallowly lobed stipules (versus 9–10 mm long and deeply

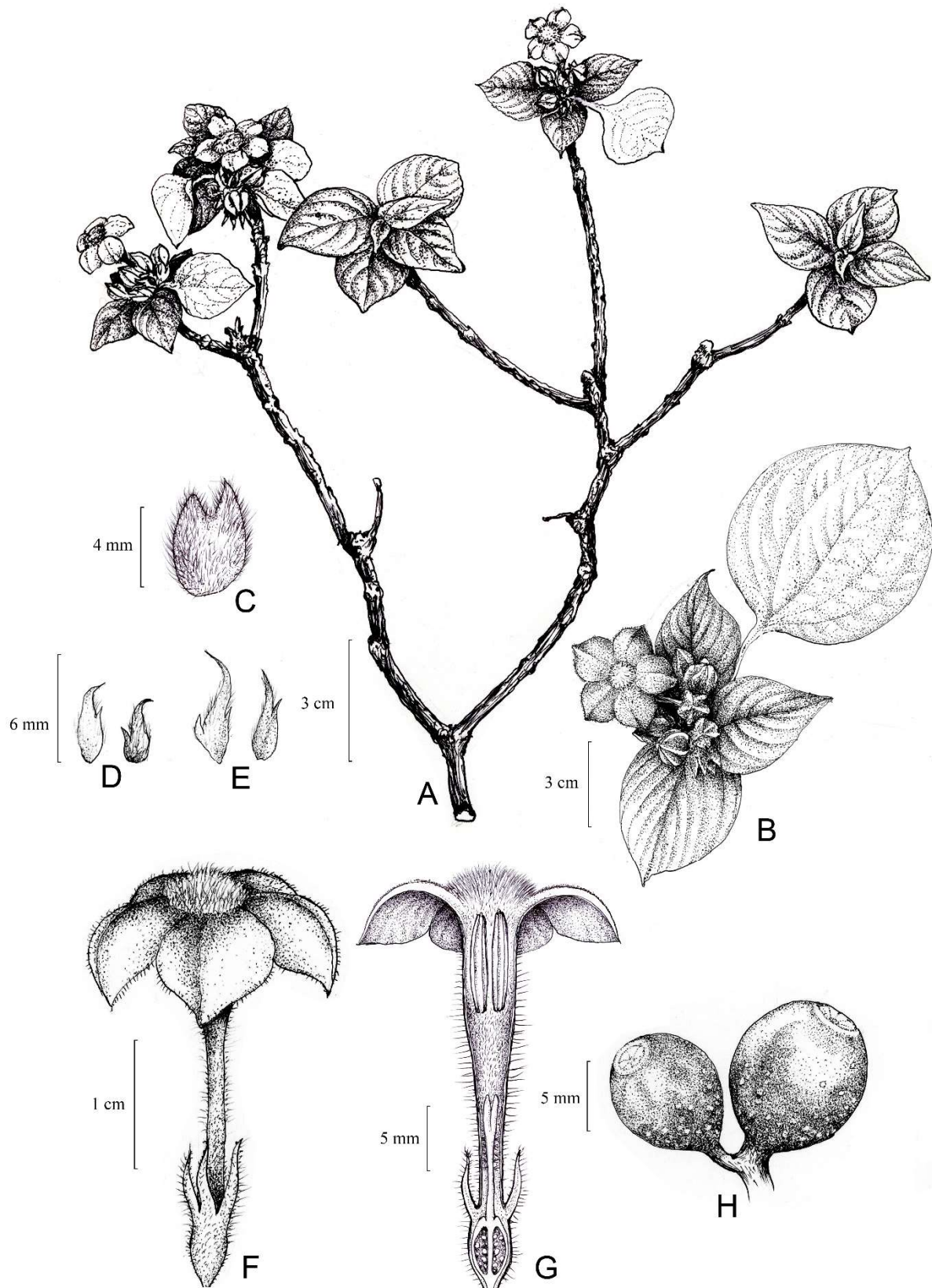


Fig. 1. *Mussaenda conferta*. **A.** Flowering branch. **B.** Dorsal view of an inflorescence. **C.** Stipule. **D.** Bracts. **E.** Bracteoles. **F.** Flower (short-styled). **G.** Longitudinal section of a flower. **H.** Fruits. Drawn by A. T. Durgadas.



Fig. 2. *Mussaenda conferta*. **A.** Habit observed during monsoon. **B.** Habit observed in the post-monsoon. **C.** Bark of mature stem and lenticellate younger branches (inset). **D.** Adaxial surface of leaves. **E.** Abaxial surface of leaves. **F.** Flowering twig showing calycophyll and dorsal view of corolla lobes (inset). **G.** Ventral view of inflorescence. **H.** Fruits. **I.** Seeds.

**Table 1.** Morphological comparison between *Mussaenda conferta* and *M. hirsutissima*.

| Structures | <i>M. conferta</i> | <i>M. hirsutissima</i> |
|-----------------|---|---|
| Habit | erect shrubs | climbing shrubs |
| Stipules (size) | 5–7 × 2.5–4 mm | 9–10 × 4.5–8 mm |
| Leaves | ovate-elliptic, 2–5 × 1–3 cm, villose on both surfaces | elliptic-lanceolate, 4.5–11 × 2.5–5 cm, shaggily hirsute or pilose on both surfaces |
| Inflorescence | capitate, 2.5–3 × 1–1.5 cm, villose, sessile | dichotomously branched, 3.5–6 × 2.5–3.5 cm, pilose, pedunculate |
| Flower bud | sparsely pubescent, green | densely pilose, red |
| Calycophylls | ovate to orbicular, 3.5–6 × 2.3–4.2 cm, stipe 1–1.5 cm long | ovate-elliptic, 5.5–10 × 2.7–7 cm, stipe 2.5–4 cm long |
| Corolla lobes | ovate to broadly obovate, 8–10 × 6–7 mm, cuspidate at apex | ovate-lanceolate, 5–12 × 4.5–8 mm, acuminate at apex |
| Fruits | subglobose, 1–1.2 × 0.8–1 cm | elliptic or globose, 1–1.2 × 1–1.2 cm |

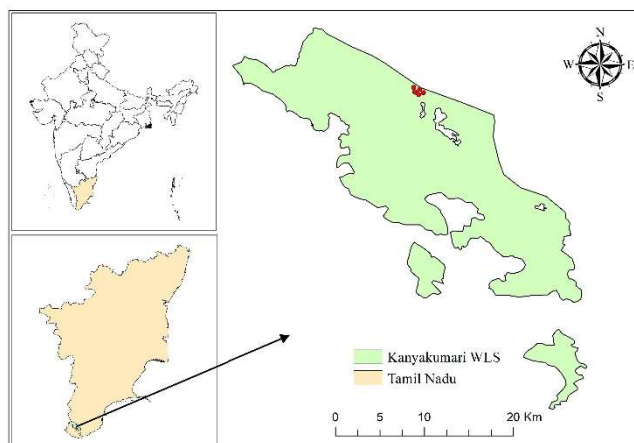
lobed in *M. hirsutissima*), ovate to orbicular calycophylls (versus ovate-elliptic in *M. hirsutissima*), sessile inflorescence (versus pedunculate in *M. hirsutissima*), and sparsely hairy subglobose fruits (versus hirsute and elliptic or globose in *M. hirsutissima*).

Erect shrubs, deciduous, multi-stemmed, 1.5–2 m high; young twigs slightly angled, densely hirtellous, reddish; older branches terete, drying brown or black, lenticellate; lenticels abundant, longitudinally elongate, sometimes slightly raised. Stipules broadly ovate, 5–7 × 2.5–4 mm, densely pubescent abaxially, scantily pubescent adaxially, shallowly lobed or rarely entire at apex; colleters 3–6 pairs at the base. Leaves opposite; petiole 0–3 mm long, densely villous; blade ovate-elliptic, 2–5 × 1–3 cm, cuneate at base, acute or acuminate at apex, villose on both surfaces, more densely pubescent along veins, pale green abaxially, dark green adaxially, drying thinly papery; secondary veins 6 or 7 on each side of midrib, prominent abaxially; tertiary veins irregularly scalariform, prominent abaxially. Inflorescence capitate, congested-cymose, 2.5–3 × 1–1.5 cm, 5–9-flowered, villose, sessile; bracts and bracteoles 1 or 2, linear-lanceolate, 4–6 × 1–1.5 mm, entire or trilobed, lateral lobes shorter, acute at apex, densely hirsute abaxially, glabrous adaxially. Flowers monomorphic, subsessile or sessile. Calyx moderately to densely strigillose to strigose; hypanthium ellipsoid to turbinate, 3–5 mm long; lobes 5, narrowly lanceolate, 6–7 × 0.8–1.1 mm, acute at apex, densely villose abaxially, puberulent adaxially, deciduous. Calycophylls ovate to orbicular, 3.5–6 × 2.3–4.2 cm, strigillose to villosulous on both surfaces, rounded or truncate at base, shortly acuminate or mucronate at apex, yellowish-white, drying pale-brown, 5–7-veined; veins longitudinal, densely pubescent abaxially; stipes 1–1.5 cm long, villosulous. Corolla salverform, 1.2–1.5 cm in diam.; corolla tube cylindrical, 2–2.5 cm long at anthesis, yellowish green, densely white villose outside, sparsely hairy inside, densely pilose at throat; hairs ribbon-like, unstriate, yellow; corolla lobes 5, reduplicate-valvate at bud stage, pale yellow abaxially, orange adaxially, ovate to broadly obovate, 8–10 × 6–7 mm, cuspidate at apex, ciliate at margins, papillose adaxially. Stamens 5, inserted in the upper part of the corolla tube, included; filaments adnate to the tube, ca. 5 mm long; anthers dorsifixed,

linear-oblong, 5–6 mm long, apiculate at the apex. Ovary cupular, ca. 5 mm long, 2-locular, ovules numerous, placentation axile, villosulous. Style 1.2–1.5 cm long; stigma 2-lobed; lobes equal, oblong, ca. 2 mm long. Berries subglobose, 1–1.2 × 0.8–1 cm, sparsely hairy, pedicel 3–5 mm long. Seeds numerous, angular, laterally flattened, reticulate, 0.85–1.1 × 0.74–0.8 mm, brownish-black, exotestal cells with 3–8 foveae in each areole, tangential wall slightly protruded.

Phenology: Flowering was observed from January to March; fruiting was observed from June to October.

Distribution: So far known only from the Kanyakumari Wildlife Sanctuary, Tamil Nadu, South India (Fig. 3).

**Fig. 3.** Distribution of *Mussaenda conferta* (red circle) in Kanyakumari Wildlife Sanctuary, Tamil Nadu, India.

Ecology and Conservation status: *Mussaenda conferta* is an erect shrub that branches profusely and grows up to 2 m high. The species generally grows in tropical montane grasslands at 1300 m asl, preferring rocky slopes, open rock boulders, and rocky crevices of windswept vertical cliffs. The plant is deciduous from December to February and produces new leaves along with flowers by mid-February. As the species grows in grasslands, the major associates are *Chlorophytum nimmonii* Dalzell, *Chrysopogon aciculatus* (Retz.) Trin, *Chrysopogon fulvus* (Spreng.) Chiov., *Cymbopogon flexuosus* (Nees ex Steud.) Wats., *Gynura travancorica*

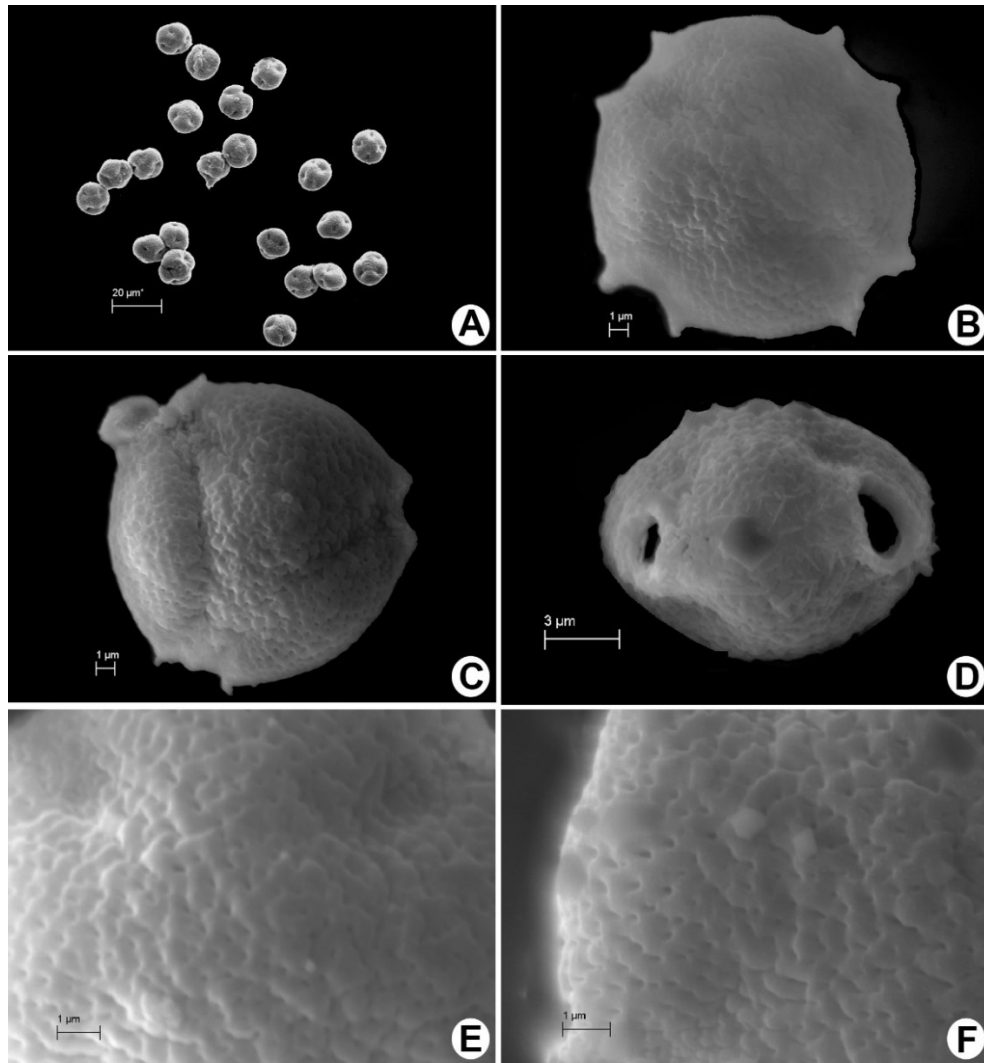


Fig. 4. *Mussaenda conferta*. A: Pollen grains. B: 4-colporate pollen showing polar view. C: 3-colporate pollen showing polar view. D: Pollen showing the equatorial view. E: Exine ornamentation at polar region. F: Exine ornamentation at interapertural region (from Sujana & Vadhyar 147531, MH).

W.W. Sm., *Hedyotis purpurascens* Hook.f., *Hypericum mysurense* Wall. ex Wight & Arn., *Syncolostemon comosus* (Wight ex Benth.) D.F. Otieno, and *Themeda triandra* Forssk. A single population of this species is observed in the Kanyakumari district of Tamil Nadu with four subpopulations having 5–8 mature individuals in less than 10 km² (Fig. 3). Hence the conservation status of this species is provisionally assessed as Critically Endangered (CR B1(a,b), C2, D) against the categories and criteria of IUCN (2022). The area of occupancy is estimated to be less than 10 km² and its habitat is severely fragmented and known to exist only in Kanyakumari Wildlife Sanctuary of Agasthyamala Biosphere Reserve. Major threats to the populations are forest fire, erratic rainfall caused by climate change, cattle grazing, and clearance of trekking paths for regular monitoring and management of wildlife.

Pollen morphology: Pollen grains monad; spheroidal, (3–)4-colporate, 15.3–16.3 × 14.5–15.0 µm; colpi

indistinct, as long as P axis, broaden toward ora, 1.8–2.6 µm wide, colpus membrane granulate; exine ornamentation rugulose with puncta at polar region and punctate at interapertural region (Fig. 4).

Etymology: The specific epithet 'conferta' refers to the crowded leaves and flowers at the distal end of branchlets during flowering periods.

Additional specimens examined: *Mussaenda conferta* (paratypes): India, Tamil Nadu: Kanyakumari district, Kanyakumari Wildlife Sanctuary, Balamore Forest Beat, Muthukuzhivayal, 08°29'2.7" N, 77°23'30.2" E, 1328 m, 24 Sept. 2020, Sujana K. A. & Rakesh G. Vadhyar 147678 CAL; Muthukuzhivayal, 15 March 1979, A.N. Henry 60704 MH [MH00122795 & MH00122796].

***M. hirsutissima*:** India, Kerala: Idukki district, On the way to Viriparai, Munnar, 1500 m, 16 Dec. 2003, C. Murugan 117625 (MH); Munnar, Mannavan shola, 1350 m, 24 June 1981, Nambiar & Muktesh1560 (KFRI); Kottayam district, Devicolam, 1580 m, 11 Sept. 1968, D.B. Deb 30714 (CAL); Thiruvananthapuram district, Top of Agasthyamala, 1400 m, 15 May 1985, N. Mohanan 2010 (TBGT). Tamil Nadu: Coimbatore district, Attakatti, 1400 m, 22 July 1978, M.

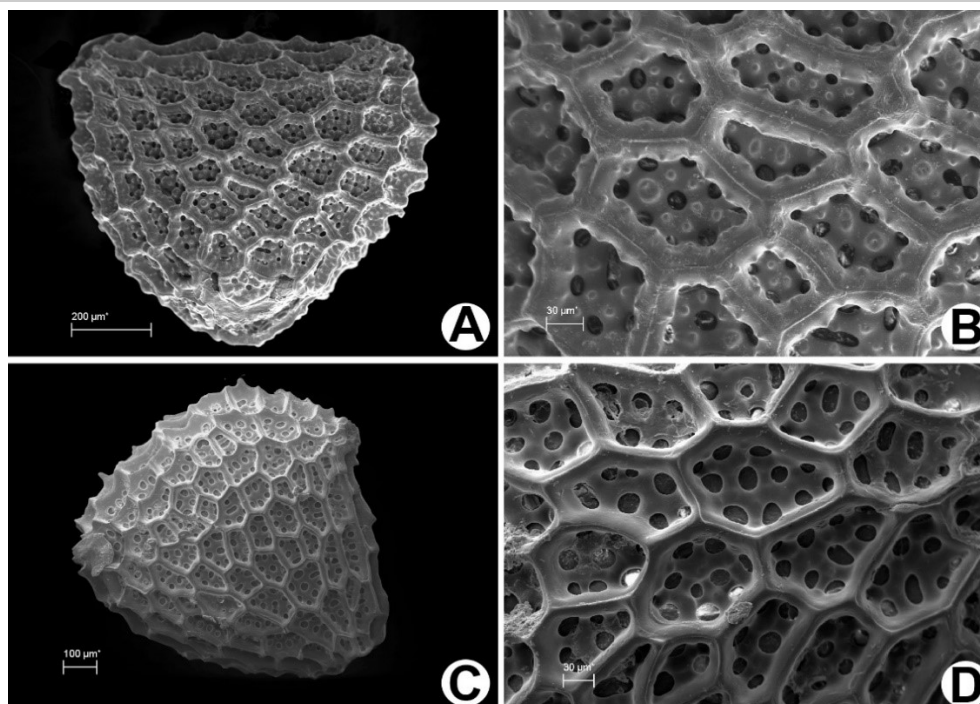


Fig. 5. SEM photographs of seed and surface ornamentation of *Mussaenda conferta* (A&B from Sujana & Vadhyar 147678, MH) and *M. hirsutissima* (C & D from Murugan 117625, MH).

Chandrabose 57238 (CAL); Theni district, Megamalai Wildlife Sanctuary, Vellimalai, 1334 m, 16 June 2017, C. Murugan & S. Arumugam 134749 (MH); Thirunelveli district, Nanguneri, Sengaltheri rest house to Neterikal path, 1100 m, 29 Mar. 1998, V.S. Manickam 15349 (XCH).

Note: Heterostyly is recognized as general feature in the genus *Mussaenda* and most of the species that morphology has been studied in India (Hooker, 1882; Gamble 1921; Jayaweera, 1963) are distylous with floral dimorphism. Most recently Shimpale *et al.* (2009) described a new species, *M. nicobarica* from Great Nicobar Island of India. Even though a detailed description with illustrations is given by the authors, the heterostylous nature of the species remained unclear. No works are available from India stating monomorphism in the genus *Mussaenda*, but there is information on monomorphic species of *Mussaenda* from China (Deng and Zhang, 2008; Duan *et al.*, 2016) and Japan (Naiki, 2008). *Mussaenda conferta* can be easily distinguished from all other Indian species by its small, congested leaves on the terminals of branches and its monomorphic flowers. From the available literatures on the pollen morphology in *Mussaenda*, the grains are usually tetraporate (Deng and Zhang, 2008; Duan *et al.*, 2016; Nong and Chen, 2017) but occasionally tri- or pentaporate were observed (Duan *et al.*, 2019; Basak *et al.*, 2022). However, the primary pollen morphological features are of limited taxonomic value in the family Rubiaceae in characterizing taxa (Dessein *et al.*, 2005). The SEM studies of seed characters revealed the distinctiveness of *M. conferta* from its morphologically similar species, *M. hirsutissima* (Fig. 5). Outer periclinal

wall of seeds of both the species are thin and smooth, while anticlinal walls are more thickened in *M. conferta* (25–30 μ m) in comparison with *M. hirsutissima* (19–20 μ m). The inner periclinal and anticlinal walls of *M. conferta* have prominent tubercular thickenings that are absent in *M. hirsutissima*.

Key to *Mussaenda* taxa in India

- 1a. Calyx lobes equal, calycophylls absent 2
- 1b. Calyx lobes unequal, calycophylls present 3
- 2a. Corolla tube less than 10 mm long, lobes orbicular, ca. 8 \times 8 mm; berries less than 9 mm long *M. tomentosa*
- 2b. Corolla tube more than 25 mm long, lobes ovate-lanceolate, ca. 20 \times 10 mm; berries more than 18 mm long *M. maingayi*
- 3a. Calyx lobes persistent in fruits 4
- 3b. Calyx lobes deciduous in fruits 8
- 4a. Inflorescence glabrous, cymes almost capitate with filiform calyx lobes 5
- 4b. Inflorescence tomentose or villous, cymes not as above 7
- 5a. Leaves densely tomentose along the veins beneath; corolla tube glabrous *M. keenanii*
- 5b. Leaves minutely puberulous or pubescent along the veins beneath; corolla tube hairy 6
- 6a. Leaves 8–16.5 \times 3.5–8 cm; corolla lobes pubescent ... *M. corymbosa*
- 6b. Leaves 10–30.4 \times 5–11 cm; corolla lobes glabrous *M. wallichii*
- 7a. Leaves oblong-lanceolate; corolla tube densely hairy within *M. roxburghii*
- 7b. Leaves ovate-oblong; corolla tube scanty hairy within *M. incana*
- 8a. Leaves glabrous on both surfaces 9
- 8b. Leaves minutely or densely pubescent on one or both surfaces ... 11
- 9a. Corolla tube more than 25 mm long at anthesis, lobes lanceolate or orbicular 10
- 9b. Corolla tube less than 25 mm long at anthesis, lobes ovate ... *M. glabra*
- 10a. Stipules triangular-lanceolate, 6.5–8.5 \times 3.5–6 mm; berries ovoid, 7.5–9 mm long *M. intuspilosa*
- 10b. Stipules ovate, 5–6 \times 3.5–5 mm; berries obovoid, 10–12 mm long .



- *M. glabrata*
 11a. Calyx lobes with a single calycophyll 12
 11b. Calyx lobes all developed in to calycophylls
 *M. macrophylla* var. *grandisepala*
 12a. Leaves broadly obovate, lateral veins 15–18 pairs; corolla tube to
 1.8 cm long *M. nicobarica*
 12b. Leaves ovate-elliptic or elliptic-lanceolate, lateral veins 6–10 pairs;
 corolla tube to 3.2 cm long 13
 13a. Stipules more than 10 mm long; corolla lobes ovate-orbicular ... 14
 13b. Stipules less than 10 mm long; corolla lobes ovate-lanceolate or
 reniform 15
 14a. Leaves scantily pubescent on both surfaces; calyx lobes linear or
 subulate, 4.5–12 × 0.7–1 mm *M. treutleri*
 14b. Leaves puberulous above, hirsute beneath; calyx lobes lanceolate,
 8.5–14 × 1.2–4 mm *M. macrophylla* var. *macrophylla*
 15a. Corolla lobes 2–3 × 3–3.5 mm; berries to 8 mm long ... *M. parryorum*
 15b. Corolla lobes 3–12 × 4–8 mm; berries 1–1.2 cm long 16
 16a. Branchlets and leaves softly hairy; inflorescence spreading 17
 16b. Branchlets and leaves roughly hirsute or pilose; inflorescence
 congested 18
 17a. Corolla tube 2.5–3.2 cm long, lobes 5.5–7 × 5–6 mm; berries
 obovoid *M. laxa*
 17b. Corolla tube 2–2.7 cm long, lobes 3–4.5 × 4–5 mm; berries
 globose *M. frondosa*
 18a. Plants erect; leaves ovate-elliptic, 2–5 × 1–3 cm; corolla lobes
 ovate to broadly obovate; berries subglobose *M. conferta*
 18b. Plants climbing; leaves elliptic-lanceolate, 4.5–11 × 2.5–5 cm;
 corolla lobes ovate-lanceolate; berries elliptic or globose
 *M. hirsutissima*

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Supplementary materials are available from Journal Website