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Research Article

## Notes on *Strobilanthes cuspidata* with reinstatement of *Endopogon versicolor* (Acanthaceae)

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### Abstract

*Endopogon versicolor* Wight, previously treated as a synonym of *Strobilanthes cuspidata* (Benth.) T. Anderson, is reinstated as a distinct species and a new name *S. benthamii* B. Mani, Sinj. Thomas, Britto, A.K. Pradeep, Y.F. Deng & E.S.S. Kumar is necessarily proposed here. It differs from *S. cuspidata* by the stem and leaf indumentum, bract/calyx length ratio, corolla shape, pollen morphology, etc. Detailed descriptions, illustrations, pollen morphology and comparison with similar species are provided.

**Keywords:** Acanthaceae; *Endopogon*; *Strobilanthes*; Nomenclature; Pollen; Taxonomy

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### Introduction

*Strobilanthes* Blume (1) is the second largest genus in the family Acanthaceae. It consists of approximately 450 species widely distributed in tropical and subtropical regions of Asia (2). In the past, there were disagreement on whether a broad or narrow circumscription of the genus might be adopted. Nees (3) was the first to recognize several genera to accommodate the species of *Strobilanthiniae*. Bremekamp (4) divided *Strobilanthiniae* into 54 genera, but the recent molecular phylogenetic studies rejected the division

proposed by Bremekamp and a single broad circumscription for *Strobilanthes* has been accepted (5-7).

The genus *Endopogon* was established by Nees (3) as “*Corolla bilabiata inflata, labio superiore bifido latiore, intus in canali pilis cincto stylum recondense.....stamina duo..spicae bracteatae floribus oppositis solitaris*” with three species, viz. *Endopogon amomum* Nees, *Endopogon hypoleucus* Nees including two unnamed varieties  $\alpha$  and  $\beta$ , and *Endopogon consanguineus* Nees. This genus is characterized by its bilabiate corolla, two stamens

and four-seeded capsules. *Endopogon hypoleucus* Nees var.  $\beta$  differs from var.  $\alpha$  by its campanulate corolla and it was later described as a new species by Carine *et al.* (8) as *Strobilanthes carnatica* Carine, J.M.Alexander & Scotland. Several years later Nees described six additional taxa of *Endopogon* including *E. viscosus* Arn. ex Nees from Ceylon (Sri Lanka) with a variety viz. var. *humilis* Wight from Courtallum, Tamil Nadu based on Wight's collections.

In his *Icones Plantarum Indiae Orientalis*, Wight (9) described *Endopogon* to possess those species having campanulate-infundibuliform corolla, two stamens and capsules with four seeds. Later, the diagnostic features of bilabiate vs. campanulate corolla caused taxonomic confusion. Simultaneously, Wight (9) described and illustrated (t. 1497) a new species, *E. versicolor* from the Nilgiris, which has campanulate corolla. In the protologue, Wight compared *Endopogon versicolor* with *E. hypoleucus* which has bilabiate and ventricose corolla. Therefore, it is now presumed that both Nees and Wight did not give due weightage on the shape of the corolla while preparing the description of these species. Furthermore, the material (Wight n. 1497, Neilgherries) used by him has campanulate corolla. It could be presumed that Wight may erroneously labelled the material when he described and illustrated the species *E. versicolor* using Wight 1498 and hence annotated "*Endopogon versicolor*, Icones 1498, Neilgherries" on that specimen. Later, Clarke (10) corrected it as "Wight Ic. t. 1497". It is now evident that the Icones 1498 is *E. viscosus* Nees var. *humilis* and was labelled as "*Endopogon viscosus* var. *humilis*, Ic. 1498, Courtallum". The latter is totally different from the former and the illustration and description of Icones No. 1498 matches with the latter only. Wight (11) again published the same illustration of *E. versicolor* in Illustrations of Indian Botany.

Anderson (12–13) merged *Endopogon* with *Strobilanthes* and treated it as a subgenus, *Strobilanthes* subgen. *Endopogon* (Nees) Anderson, and listed *E. versicolor* under synonymy of both *Strobilanthes cuspidatus* (Benth) Anderson and *S. viscosus* (Arnott ex Nees) T. Anderson. He considered that Wight's description in the text of t. 1497 is referred only to *S. cuspidatus* while the illustration of t. 1497 is identical with *S. viscosus* (13). Accordingly, *E. versicolor* was subsequently reduced to *S. cuspidatus* by Clarke (10) or *S. viscosus* by Beddome (14). Clarke's treatment was followed by several authors (15–18).

*Strobilanthes cuspidatus* was originally described as *E. cuspidatus* Benth (19) based on Hohenacker's material (Hohenacker 1169, K) collected from Neilgherries (Nilgiris). It is similar to *E. hypoleucus* in having spicate inflorescence, bilabiate corolla and four seeded capsules. Since then, it has been collected from different regions

of the Neilgherries evidently by the specimens housed at K, E, OXF, BM, CAL, MH, and TBGT. After perusal of specimens and digital images, it is confirmed that there are two different morphotypes of plants involved in these collections. One with campanulate corolla and the others with bilabiate corolla. It is interesting to note that the *E. cuspidatus* is quite distinct by its bilabiate and ventricose corolla, whereas *E. versicolor* is having subequal corolla lobes.

In his *Icones Plantarum Indiae Orientalis*, Beddome (14) provided the description and illustration for *S. cuspidatus* and synonymized *E. versicolor* under *S. viscosus*. However, the illustration he provided for the species has a perfect match with *E. versicolor*.

When Carine *et al.* (8) presented a detailed account on *S. kunthiana* (Nees) T. Anderson ex Benth. group (*Phlebophyllum* sensu Bremekamp), they adopted the treatment of Clarke to treat *E. versicolor* as the synonym of *S. cuspidata*. They also stated that corolla of *S. cuspidata* is campanulate to subventricose and illustrated as such. It is apparent that they examined materials of both *E. versicolor* and *E. cuspidatus* for the description provided. They also pointed out that Anderson (12) erroneously treated illustration of *E. versicolor* (Wight t. 1497) as *E. viscosus* and they considered *S. cuspidata* to be endemic to the Nilgiris.

In the present paper, we revised the taxonomic problems on *S. cuspidata* and *E. versicolor* on the basis of the analysis of gross vegetative morphology and palynological characters using fresh specimens, herbarium materials and literature. Pollen grains were collected from fresh specimens of all the taxa. The grains were washed in water by sonication. The air dried pollens were fixed to aluminium stubs and sputter-coated with gold. Morphological observations were made and micrographs were then taken with JEOL (JSM-6390LV/JED-2300) SEM-EDS. The variability of pollen morphology in *Strobilanthes* is potentially a useful character to delimit taxa in this group (3, 6, 20–21). *Endopogon versicolor* differs from *S. cuspidata* by its campanulate corolla and apiculate pollen grains with straight ribs. Therefore, *E. versicolor* is absolutely different from *S. cuspidata* and allied to *S. carnatica* whereas *E. cuspidatus* is allied to *S. consanguinea* as Benth stated.

Accordingly, *E. versicolor* is reinstated here as an independent species in *Strobilanthes*. Since the name *S. versicolor* Diels (22) antedated for a Chinese species, a new name *S. benthamii* is proposed here to accommodate *E. versicolor*.

### Taxonomy

***Strobilanthes benthamii*** B. Mani, Sinj. Thomas, Britto, A.K. Pradeep, Y.F. Deng & E.S.S. Kumar, **nom. nov.** (Fig. 1 & 2)

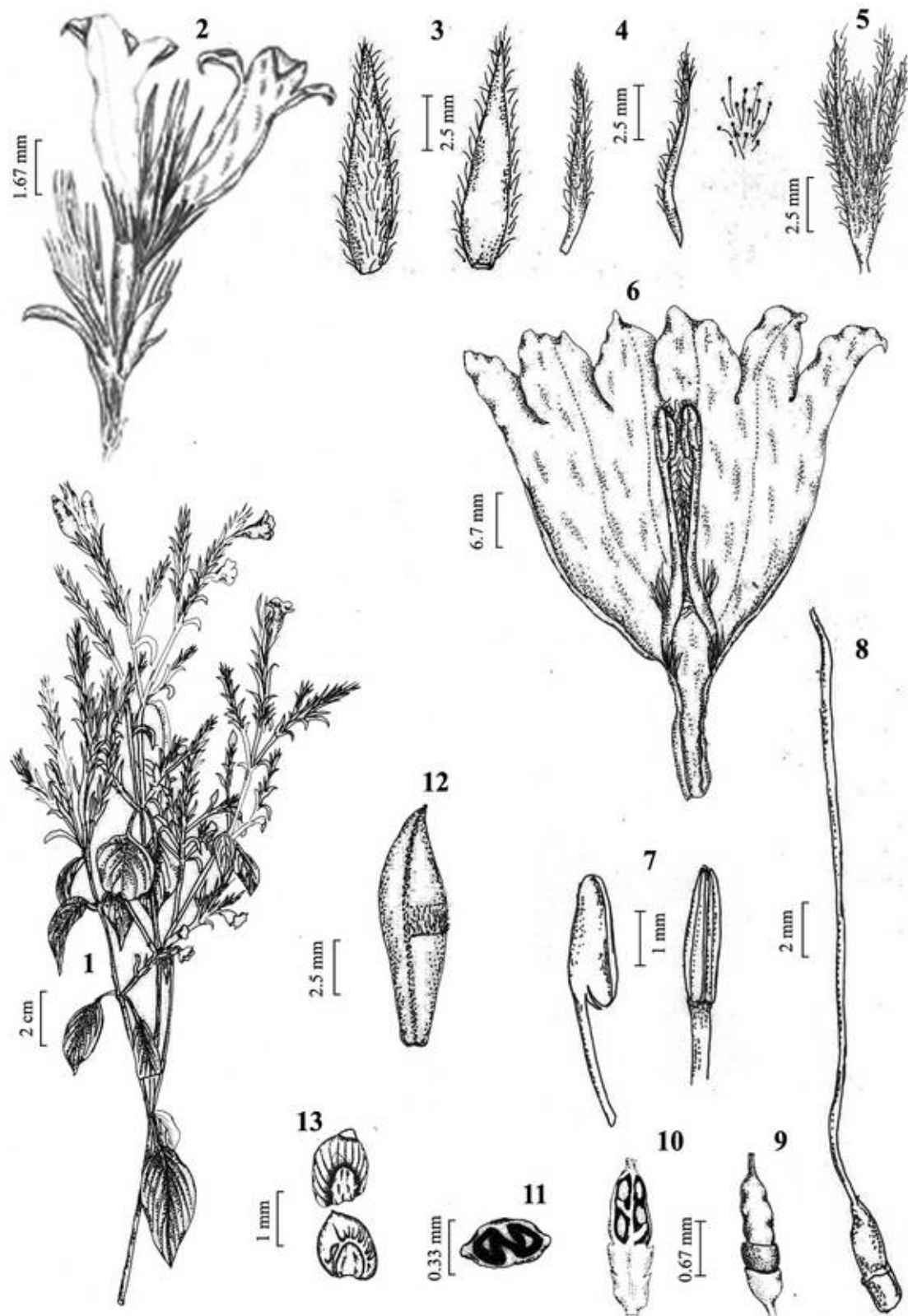


Fig. 1. *Strobilanthes benthamii*. 1. Habit; 2. Inflorescence; 3. Bract; 4. Bracteole; 5. Calyx; 6. Corolla split opened; 7. Anther; 8. Pistil; 9. Ovary; 10. Ovary L.S.; 11. Ovary T.S.; 12. Fruit; 13. Seeds (RHT68803). Illustrated by Philominal Selvi.

Replaced name: *Endopogon versicolor* Wight, Icon. P1. Ind. Orient. 4(3): 19, t. 1497 (1849).

– *Phlebophyllum versicolor* (Wight) Bremek. in Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., Sect. 2, 41(1): 169 (1944), non *Strobilanthes versicolor* Diels (1912: 163).

**Type:** INDIA. Tamil Nadu: Neilgherries, *Wight s.n.* [1498] (lectotype designated here, K000882933, image!). **Syntypes:** INDIA. Peninsula Indiae, *Wight* 2206 (K000882934: image!); Tamil Nadu: Neilgherries, *Wight s.n.* (K000882935: image!); *Wight s.n.* (K000882936: image!).





**Fig. 2.** Field images of *Strobilanthes benthamii*. 1. Habit; 2. Inflorescence; 3. Bract; 4. Bracteole; 5. Calyx; 6. Corolla split opened; 7. Stamen; 8. Pistil; 9. Infructescence; 10. Seeds.

Shrubs, up to 2.5 m high. Stem quadrangular (young) to terete (mature), young stem covered with dense sericeous indumentum,

glandular hairy on uppermost sections at anthesis. Leaves opposite, slightly asymmetrical; petioles to 7.0 cm long, tomentellous; lamina ovate-elliptic,

3.0–13.2 × 1.8–8.6 cm, shortly decurrent at base, slightly crenate along margins, acuminate–acute at apex, abaxially dense white sericeous, adaxially glabrous; lateral veins 7–12 pairs, prominent abaxially, less so adaxially. Inflorescence of an uninterrupted to interrupted spikes, 1.7–11.5 cm long, 4–7 mm broad, glandular hairy (viscous); axis glandular pubescent; flowers in opposite pairs. Bracts lanceolate, 11.0–12.5 × 2–3 mm, longer than calyx at anthesis, acuminate at apex, often recurved, glandular hairy along margins, abaxially glandular hairy, adaxially glandular-hairy at apex. Bracteoles linear, 8–9 mm long, abaxially glandular hairy, adaxially pubescent; secondary flower buds present. Calyx 5-lobed; two lobes shorter than other three, fused from base for  $\frac{1}{3}$ – $\frac{1}{2}$  of length at anthesis; lobes lanceolate, 9–11 mm long, acute at apex, abaxially glandular-hairy, adaxially pubescent. Corolla bluish, 2.6–2.9 cm long; basal tube cylindrical; tube 6–7 mm long, glabrous; throat campanulate, 14–16 mm long, densely fine pubescent outside, inside long hairy along adaxial side; lobes equal, widely elliptic, 5–7.5 × ca. 6 mm, overlapping, fine pubescent outside, glabrous inside. Stamens 2, included, basally attached with corolla; anthers 1.8–2.5 mm long, thecae 2, violet, held parallel with filament; filaments 8–10 mm long, long white hairs for proximal  $\frac{3}{4}$  length; Ovary 1.5–2 mm long, sparsely pubescent at apex, 2-locular; 2 ovules per locule; style 18–19 mm long, filiform, fine pubescent throughout; stigma 2.5–3.0 mm long, sparsely pubescent. Infructescence 7.5–11.4 × 0.8–1.0 cm, glandular hairy (viscous); calyx covering the capsule. Capsule oblanceolate, 11.0–12.0 × 3.0–3.5 mm, apically pubescent. Seeds 4 (rarely 2), 2–3 × 2–2.5 mm, ovate–wide elliptic, truncate at base, cuspidate at apex, densely pubescent.

**Habitat and distribution:** *Strobilanthes benthamii* grows as patches under moist deciduous forest and also on exposed slopes on hillsides at elevations ranging from 1100–1400 m a.s.l. in the eastern slopes of the Western Ghats.

**Notes:** *Strobilanthes benthamii*, a Nilgiri endemic, was wrongly treated by various authors (8, 13–14, 16–20) since 1864. It was suggested to be similar to *S. cuspidata* in the characters of white sericeous indumentum on abaxial surface of the leaves, often uninterrupted glandular-viscous spikes, recurved bracts, unequal calyx lobes, included stamens, viscous infructescence and four seeded capsules. However, *Strobilanthes benthamii* can be easily distinguished from the latter in having white sericeous indumentum on young stem, glabrous adaxial leaf surface, bracts exceeding the calyx, campanulate corolla with equal lobes, elliptic anthers and prolate-apiculate pollen grain with straight ribs (Fig. 5.1 & Table 1). *Strobilanthes benthamii* occurs in different parts of the Nilgiris even though each population has limited number of individuals.

Carine *et al.* 2004: 20 (8) indicated the type to be “Neilgherries, Wight s.n. (lectotype: K!).” However, this was not an effective lectotypification because they failed to use the phrase “designated here” (*hic designatus*) or an equivalent that required by Art. 7.11 of the ICN (23). Here, we formally designated the same specimen as the lectotype using the phrase “designated here”.

*Strobilanthes benthamii* is also allied to *S. carnatica* Carine *et al.* (8), but differs by robust habit, glandular hairy stem at anthesis, ovate-elliptic leaves with acuminate-acute apex, 7–12 pairs of lateral veins, white sericeous abaxial

**Table 1.** Comparison of pollen features of *S. benthamii*, *S. carnatica*, *S. cuspidata* and *S. consanguinea*.

Species	Pollen class	Shape	Pseudocolpi	P (µm)	E (µm)	P:E ratio	Ribs
<i>S. benthamii</i>	Prolate	Apiculate	Moderately wide	70–81	51–55	1.40	32–36, straight
<i>S. carnatica</i>	Subprolate	Widely ovate	Narrow	37–39	29–31	1.26	27, straight
<i>S. cuspidata</i>	Prolate	Terete	Wide	47–52	31–34	1.50	16–18, spiral
<i>S. consanguinea</i>	Perprolate	Barrel	Narrow	48–53	24–26	2.02	18–21, spiral

**Pollen morphology:** Pollen grains are ellipsoid, tricolporate and contain pseudocolpi (Fig. 5.1). The grains are prolate in outline and fusiform. The exine divided into longitudinal ribs which are close, straight and tectate. Tectum perforates. A comparison of pollen features with allied species (Fig. 5.2) is given in Table 1.

**Etymology:** The species is named after George Bentham for his contributions to the field of Botany.

**Phenology:** Flowering January–March; seed dispersal starts in April.

indumentum on leaves, often uninterrupted broad spikes which are viscous, bracts exceeding the calyx, larger corolla, widely elliptic corolla lobes, prolate-apiculate pollen grains with moderately wide pseudocolpi (Fig. 5.1 & Table 1 & 2), pubescent style and stigma and oblanceolate and puberulent capsules. Moreover, *S. carnatica* is distributed in the Eastern Ghats only (8).

**Specimens examined:** INDIA. Tamil Nadu: Nilgiri district, Sigur, 1800 m a.s.l., Nov 1884, *Gamble 15670* (MH); Nilgiris, 1500 m a.s.l., 18 Feb 1972, *Sharma 39843* (MH); Nilgiris, 1800 m a.s.l., 29 Jan. 1972, *Vajravelu 39696* (MH); Nilgiris, 1650 m a.s.l., 5 Jan 2017, *Pradeep et al. 68493* (RHT); 1 Apr 2017,



*Pradeep et al. 68596* (RHT); 16 Jan 2018, *Pradeep et al. 68803* (RHT); 12 Feb 2018, *Pradeep et al. 68804* (RHT); 11 Mar. 2018, *Pradeep et al. 68805* (RHT).

***Strobilanthes cuspidata*** (Benth.) T. Anderson, J. Linn. Soc., Bot. 9: 465 (1867). (Fig. 3 & 4)

Basionym: *Endopogon cuspidatus* Benth., Linnaea 24: 646 (1851).

long, fine pubescence outside, inner side with two lines of long white hairs on the adaxial side; lobes unequal, folded back, two adaxial lobes partly fused and hooded, widely elliptic, 1.1–1.3 × 1.0–1.2 cm, fine pubescent outside, glabrous inside. Stamens 2, included; filaments 1.1–1.15 cm long, glabrous except at point of fusion with corolla; anthers sagittate, 3.5–4.0 × ca. 1 mm, thecae 2, held parallel to filament. Ovary 2.5–3 mm long, apex

**Table 2.** Comparison of morphological characters of *S. benthamii* and *S. cuspidata*.

Characters	<i>S. benthamii</i>	<i>S. cuspidata</i>
<b>Stem (young)</b>		
Indumentum	Sericeous	Tawny tomentose
<b>Leaf blade</b>		
Shape	Ovate to elliptic	Ovate
Apex	Acuminate to acute	Acuminate to cuspidate
Margin	Slightly crenate	Entire or slightly crenate
Adaxial indumentum	Glabrous	Pubescent
<b>Bract</b>		
Adaxial indumentum	Glandular hairy at apex	Glandular hairy at upper ½ part
Bract:calyx ratio	Longer	Shorter
<b>Corolla</b>		
Shape	Campanulate	Ventricose
<b>Stamens</b>		
Filaments	Long white hairs for proximal ¾ length	Glabrous
Anthers	Elliptic	Sagittate

**Type:** INDIA. Tamil Nadu: Nilgiris, *Hohenacker 1169* (lectotype designated by Carine *et al.*, K000882938; E00160838, MPU018233, images!, U0000079 image!), LECB0001800 image!, JE 00002184 image!, JE 00002185 image!, JE 00002186 image!, HAL 0113941 image!).

Shrubs, up to 1.5 m high. Stem quadrangular to terete; young stem tawny tomentose; mature stem lenticellate. Leaves opposite, symmetric; petioles 3.5–7.0 cm long, tomentose; blade ovate, 4.8–12.5 × 2.5–7.6 cm, shortly decurrent onto the petiole at base, entire or slightly crenate along margins, acuminate–cuspidate at apex, densely tawny hairy on both surfaces when young, becoming white sericeous abaxially and pubescent adaxially; lateral veins 6–12 pairs, prominent on both surfaces, raised beneath. Inflorescence of often uninterrupted spikes, 3.2–9.0 × 0.7–0.8 mm at anthesis, glandular hairy (viscous); peduncle covered with glandular hairs; flowers in opposite pairs. Bracts lanceolate, 10–11 × 2.5–3.0 mm, shorter than calyx at anthesis except for lowermost ones, acuminate at apex, recurved, abaxially glandular hairy, adaxially glandular hairy on upper ½ portion. Bracteoles linear, 9–10 mm long, abaxially glandular hairy, adaxially pubescent; secondary flower buds present. Calyx 5-lobed; two lobes shorter than other three, fused from base for ½–⅔ of length at anthesis; lobes lanceolate, 1.1–1.2 cm long, acuminate at apex, abaxially densely glandular hairy, adaxially fine pubescent. Corolla bluish, 2.7–2.9 cm long, inflated, basal tube cylindrical, 6.5–8.0 mm long, glabrous; throat ventricose, 1.4–1.5 cm

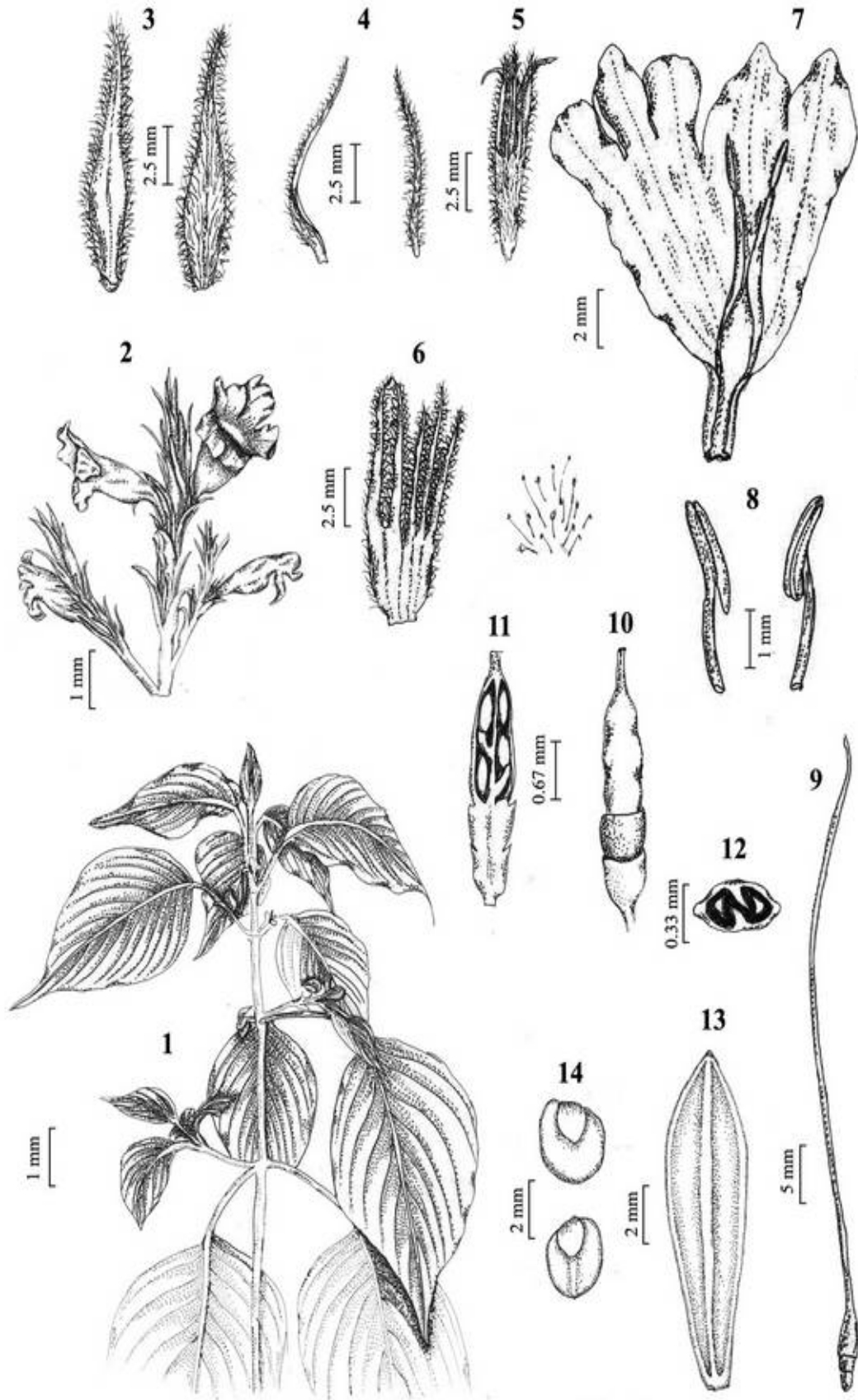
glandular pubescent; style ca. 1.7 cm long, filiform, fine hairs present on lower ¾ portion; stigma linear, ca. 2.5 mm long, fine pubescent. Infructescence 4.0–14.0 × 0.8–1.0 cm, densely glandular hairy (viscous). Capsule oblanceolate, 0.9–1.2 × 0.3–0.4 cm, hairy at apex. Seeds 4, 1.5–2.5 × 1.5–2 mm, widely elliptic–orbicular, truncated–semi-rounded at base, rounded at apex, densely pubescent.

**Pollen morphology:** Pollen grains are ellipsoid, tricolporate and have pseudocolpi (Fig. 5.3). The outline of the pollen is prolate (cylindrical) and exine is divided into longitudinal ribs which are thick, punctate, distant, spiral and tectate. Tectum perforates. Pollen features of allied species (Fig. 5.4) are given in Table 1.

**Phenology:** Flowering January–March and it follows a semelparous life history pattern; fruiting April–May.

**Habitat and Distribution:** It grows as shola forest undergrowth at elevations ranging from 1750–2000 m a.s.l. in Nilgiris, Tamil Nadu.

**Notes:** *Strobilanthes cuspidata*, a species endemic to Nilgiris with narrow distribution, has often been confused with *E. versicolor* by many authors. Bentham (19) described the species based on Hohenacker's collection without providing an illustration. Anderson, Beddome and Clarke wrongly synonymised *E. versicolor* under *S. cuspidata* and followed by others (8, 15–17). This species is definitely distinguished from *E. versicolor* (*S. benthamii*) by the characters of tawny tomentum on young stems, leaves with adaxial



**Fig. 3.** *Strobilanthes cuspidata*. 1. Habit; 2. Inflorescence; 3. Bract; 4. Bracteole; 5. Calyx; 6. Calyx split opened; 7. Corolla split opened; 8. Anther; 9. Pistil; 10. Ovary; 11. Ovary L.S.; 12. Ovary T.S.; 13. Fruit; 14. Seed (RHT68806). Illustrated by Philominal Selvi.



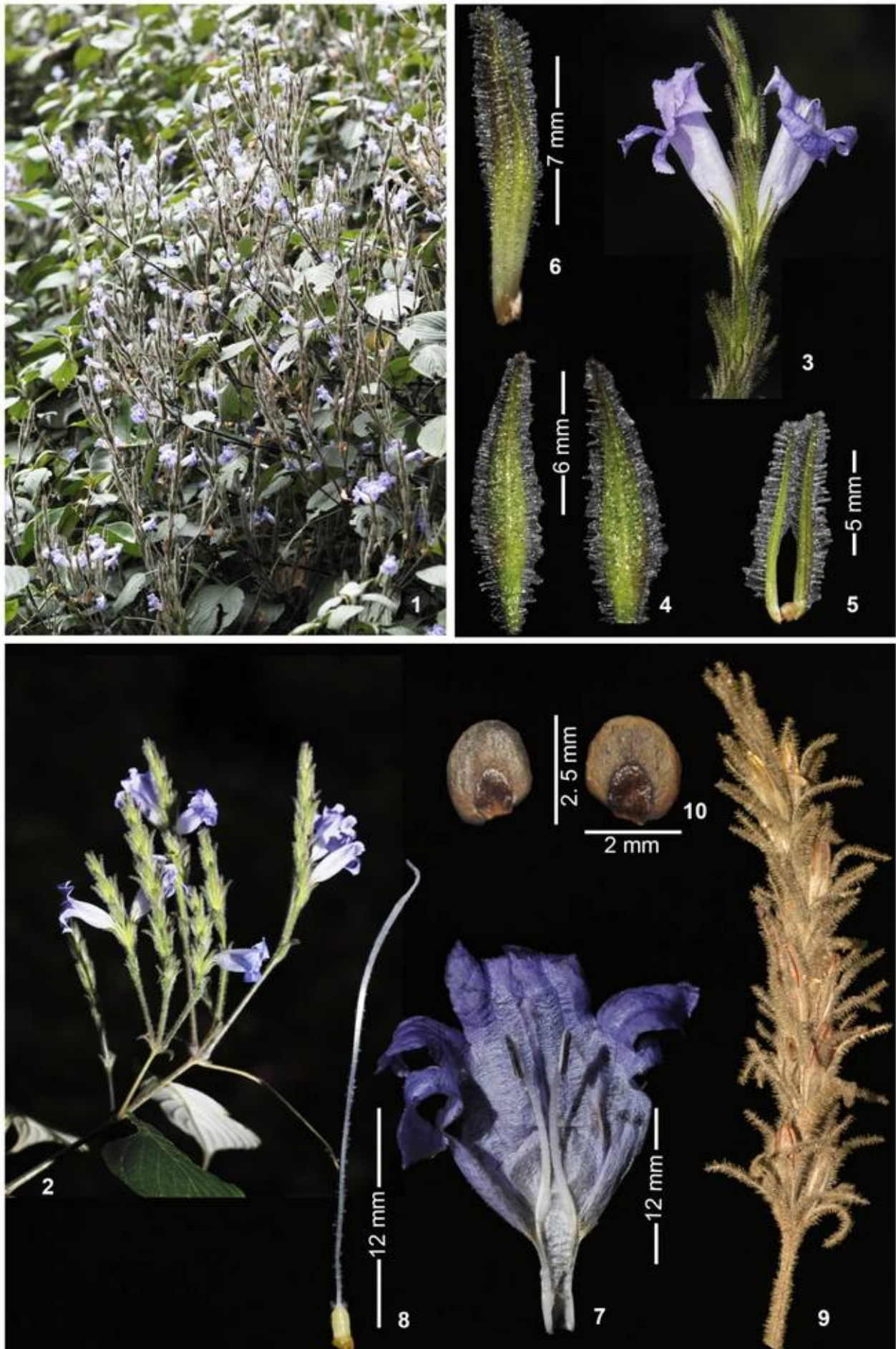


Fig. 4. Field images of *Strobilanthes cuspidata*. 1. Habit; 2. Inflorescence; 3. Pair of flowers; 4. Bract; 5. Bracteole; 6. Calyx; 7. Corolla split opened; 8. Pistil; 9. Infructescence; 10. Seeds.



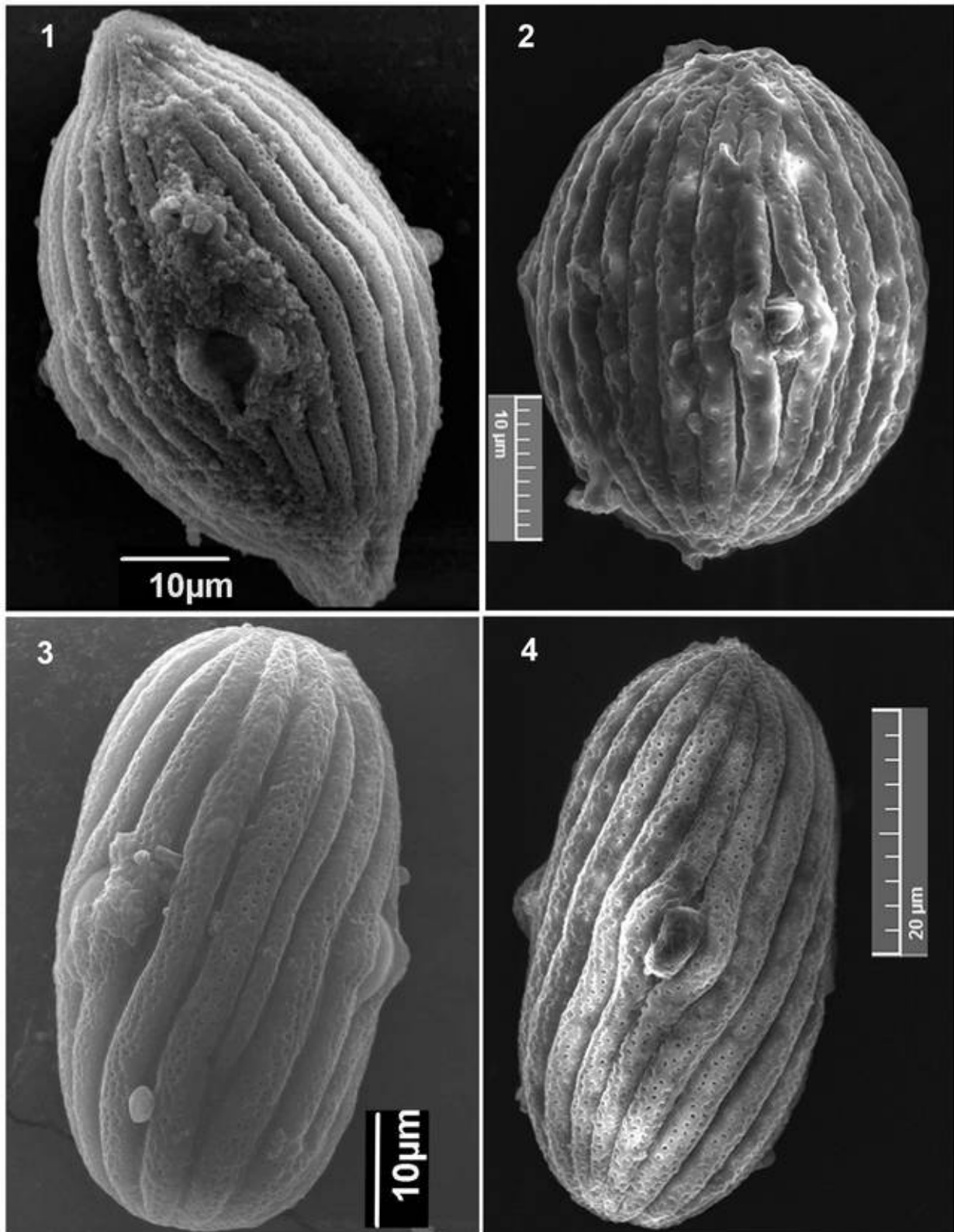


Fig. 5. Scanning electron micrographs (SEM) of pollen grains of *S. benthamii* (1), *S. carnatica* (2), *S. cuspidata* (3) and *S. consanguinea*.

pubescence, bracts being shorter than calyx, ventricose corolla with unequal lobes in which adaxial lobes are hooded, with sagittate anthers, prolate-barrel shaped pollen grains with spiral ribs (Fig. 5.3 & Table 1 & 2).

It is allied to *S. consanguinea* (Nees) T. Anderson, which is widely distributed in the Western Ghats. However, it can be easily distinguished from the latter by having tawny young stem (vs. glabrous or rarely pubescent young stem), strictly white sericeous abaxial leaf indumentum (vs. glabrous or rarely white

indumentum on abaxial leaf surface), broad spikes (vs. narrow spikes) strictly glandular hairy (viscous) floral parts such as peduncle, bracts, bracteoles and calyx (vs. glabrous or rarely sparsely pubescent or glandular floral parts at the time of anthesis), bracts shorter than calyx (vs. bracts equal to the calyx), presence of secondary flower buds in the axis of bracteole (vs. absence of secondary flower buds), unequal calyx lobes (vs. equal), long corolla (vs. short corolla), widely elliptic corolla lobes (vs. narrowly triangular), included stamens (vs. exserted), sagittate anther (vs. elliptic) and pubescent style (vs. glabrous style).

The pollen morphology of *S. cuspidata* (Fig. 5.3) differs from that of *S. consanguinea* (Fig. 5.4) in having cylindrical pollen grains with only 16–18 ribs which are wide and prominent and wide pseudocolpi. Therefore, *S. cuspidata* is totally different from *S. consanguinea*. Moreover, it also ascertains that this enigmatic taxon has a very narrow distribution and it might be rarely found the specimens in herbaria.

**Specimens examined:** INDIA. Tamil Nadu: Nilgiri District, Nilgiri, 10 Dec 1957, *Sebastine 4886* (MH); 15 Jan. 2018, *Pradeep et al. 68806* (RHT); 30 Jan. 2018, *Pradeep et al. 68818* (RHT); 12 Feb. 2018, *Pradeep et al. 68807* (RHT); 11 Mar 2018, *Pradeep et al. 68808* (RHT).

### Competing interest

Authors declare that they have no competing interest.

### Authors' contributions

All authors contributed equally to the present work.

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