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## Capsule and Seed Morphology of *Commelina* L. (Commelinaceae) in Relation to Taxonomy

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**Abstract:** The present study discusses the light microscopic studies on the capsule and SEM studies on seed of 22 species of *Commelina* occurring in India and their significance in taxonomy. The characters of capsule studied include the size and shape and the number of capsule within a spathe. Similarly, the seed characters studied include the number, shape, size and colour and ornamentation of testa. The findings indicate that the capsule and seed characters are the best bet in the species level classification within this genus. A key for the identification of each species based on capsule and seed characters is also included.

**Key words:** *Commelina*, light microscopy, SEM, capsule and seed morphology, taxonomy

### INTRODUCTION

The genus *Commelina* L. belongs to the family Commelinaceae and comprises about 205 species in the world (Govaerts, 2009). It is represented by 22 species in India (Karthikeyan *et al.*, 1989) and is fairly distributed in southern India with 18 species. The genus is easily distinguished from other genera of this family by its annual or perennial herbaceous habit, terminal and leaf opposed inflorescence composed of one or two cincinni enclosed in a folded spathe, strongly zygomorphic flowers, unequal petals with one anterior reduced petal, 3 stamens and 2-3 staminodes, usually 4-6 lobed antherodes, bi or tri-loculed capsules with 1 or 2 seeds per locule (Faden, 1998).

The capsule of *Commelina* is trilocular with one dorsal locule and two ventral locules. The dorsal locule is 1 seeded or aborted and mostly indehiscent. The ventral locules are 2 seeded or 1 seeded and very rarely 1 is aborted. The seeds possess a lateral embryotega and a linear hilum. These characters are constant among species and the aim of this paper is to examine the capsule and seed morphology of 22 species of *Commelina* and their significance in taxonomy. Nearly all species of *Commelina* occurring in India can be identified with characters of capsule and seed and this study is part of an ongoing study on the taxonomic revision of the genus in India.

### MATERIALS AND METHODS

Capsules and seeds for the present study were obtained from fresh and herbarium samples. The voucher specimens were deposited at St. Joseph's College herbarium (DEV). Mature and dry capsules were mounted

on clean glass slides and observed under Leica MZ 7.5 Stereo zoom microscope. SEM of seeds (except *C. albescens*, *C. appendiculata*, *C. coelestis* and *C. paleata*) was taken by Hitachi su-6600. Detailed data sheets on the capsule and seed morphology were prepared by thorough observation. Capsules were drawn with Camera Lucida attached to Leica MZ 7.5 Stereo zoom microscope. The data obtained were compared and presented separately for capsule and seeds (Table 1, 2).

The terminology used for the surfaces of the seed follows Faden (1991): ventral, the surface bearing hilum; dorsal, the surface opposite the ventral; apical and basal, the surfaces facing the apex and base of capsule, respectively; lateral, the surfaces, one of which bearing the embryotega, directed towards the dorsal and ventral surfaces of the capsule. Seed length is the distance between apical and basal surfaces; width, the distances between the lateral surfaces and thickness, the distance between the ventral and dorsal surfaces. Seed shape is the linear out line viewed from the dorsal surface.

### RESULTS

***Commelina albescens* Hassk.:** Capsules 1 or 2 per spathe, ca. 4×3 mm, ovate, compressed, trilocular or bilocular, dorsal locule aborted, ventral locules 1 or 2 seeded. Seeds rounded, 2-2.5 mm, testa dull black, smooth with white farinose, hilum linear, embryotega lateral (under LM).

**Specimen examined:** India, Rajasthan, Jaisalmer, Dwarka, 16/10/1961, T.A.Rao 76568 (BLAT).

Table 1: Morphological characters of the capsules of *Commelina* species

Name	No. Capsule /spathe	Shape	No. of locules	No. of seeds in dorsal locule	No. of seeds in ventral locules	Size (mm)
<i>C. albescens</i> Hassk.	1 or 2	Ovate	3 or 2	Absent	2 or 4	4×3
<i>C. appendiculata</i> C.B. Clarke	1 or 2	Globose	3	1	2	10×4.5
<i>C. attenuata</i> Vahl	1	Ovoid	2	Absent	2	4-6×3-4
<i>C. benghalensis</i> L.	1	Elliptic	3	1	4	5-6×3-4
<i>C. caroliniana</i> Walter	1 or 2	Ovate-elliptic	3	1	4	5-6×2-3
<i>C. clavata</i> C.B. Clarke	2 or 3	Oblong-elliptic	2	Absent	4	8-9×4.5-6
<i>C. coelestis</i> Willd.	3 or 4	Oblong	3	1	4	6-7.5×4
<i>C. diffusa</i> Burm. f.	1-3	Oblong	3	1	4	8-9×4-5
<i>C. ensifolia</i> R.Br.	1-2	Elliptic-obovoid	2 or 3	Absent or 1	2	5-6×4-5
<i>C. forskalaiei</i> Vahl	1	Obovoid	3	1	4	5-6×3.5-4
<i>C. indehiscens</i> E. Barnes	1-3	Oblong	3	1	Absent	10-12×3-4
<i>C. kurzii</i> C.B. Clarke	1 or 2	Globose	3 or 2	Absent or 1	2	7-8×5-6
<i>C. longifolia</i> Lam.	1-2	Oblong	3	1	4	8-9×3-4
<i>C. maculata</i> Edgew.	1-2	Ovoid	3	1	2	6-7×5
<i>C. paleata</i> Hassk.	1 or 2	Oblong	3	1	2	6×4
<i>C. pahudosa</i> Blume	1-3	Obovoid	3	1	2	4×3
<i>C. petersii</i> Hassk.	1 or 2	Ovate-elliptic	2 or 3	Absent or 1	4	9-10×3-4
<i>C. sikkimensis</i> C.B. Clarke	1 or 2	Oblong	3	1	4	5-6×2-3
<i>C. subulata</i> Roth	2	Oblong	3	1	4	4.5×2.5
<i>C. suffruticosa</i> Blume	5 or 6	Globose	2	Absent	2	5×5
<i>C. tricolor</i> E. Barnes	1 or 2	Ovoid-oblong	2	Absent	4	9-10×3-3.5
<i>C. wightii</i> R.S. Rao	1	Globose	3	Absent	1	5-5.5×3.5-4

Table 2: Morphological characters of the seeds of *Commelina* species

Name	Seed No.	Seed shape	Colour of testa	Ornamentation LM/SEM	Size	Depositions on testa
<i>C. albescens</i> Hassk.	2-4	Rounded	Dull black	Smooth	2-2.5×2	White farinose
<i>C. appendiculata</i> C.B. Clarke	3	Oblong	Brown	Smooth	4.5-6×2.2-2.3	White farinose, appendage at both ends
<i>C. attenuata</i> Vahl	2	Elliptic	Dark brown	Smooth/reticulate	2-4×1-2	White farinose, appendage at both ends
<i>C. benghalensis</i> L.	5	Ovoid	Black-brown	Furrowed reticulate	2×1.5	White farinose
<i>C. caroliniana</i> Walter	5	Ovate pyriform	Dark brown	Smooth	3×2	White farinose
<i>C. clavata</i> C.B. Clarke	4	Elliptic	Dark brown	Shallowly reticulate	2.5×2-2.2	Nil
<i>C. coelestis</i> Willd.	5	Triangular	Brown/black	Pitted	3.4×2.3	Nil
<i>C. diffusa</i> Burm. f.	5	Oblong	Brown	Doubly reticulate	3-4×1.2	White farinose
<i>C. ensifolia</i> R.Br.	2 or 3	Ovoid	Dark brown	Smooth/coarsely reticulate	2.5-3.5×2-3	Torus of white material
<i>C. forskalaiei</i> Vahl	5	globose	Brown	Smooth/coarsely reticulate	2.5×2	Nil
<i>C. indehiscens</i> E. Barnes	1	Ovoid	Black-dark brown	Reticulate	5×2	Reticulations brown
<i>C. longifolia</i> Lam.	5	Ovoid	Brown	Smooth	3×2	White farinose
<i>C. kurzii</i> C.B. Clarke	3 or 2	Ovate	Brown	Smooth	3×2	Torus of brown material
<i>C. maculata</i> Edgew.	3	Oblong	Reddish brown	Smooth	3×2	Nil
<i>C. paleata</i> Hassk.	3	Oblong	Dark brown	Smooth	3×2	White farinose
<i>C. pahudosa</i> Blume	3	Ellipsoid	Dark brown	Smooth/coarsely reticulate	3-4×2.5	White farinose
<i>C. petersii</i> Hassk.	4 or 5	Ovate-pyriform	Dark brown	Ridges and furrows	4-4.5×2.5	White-light brown tubercles,
<i>C. sikkimensis</i> C.B. Clarke	5	Ovoid-oblong	Dark brown	Pitted reticulate	3-4×2-3	Nil
<i>C. subulata</i> Roth	5	Ovoid	Black	Tranverse pits	1.5×1	White farinose
<i>C. suffruticosa</i> Blume	2	Elliptic	Dark brown	Shallowly reticulate	3×2	White farinose
<i>C. tricolor</i> E. Barnes	4	Ovoid-oblong	Pale brown	Smooth	4×1.5	White farinose
<i>C. wightii</i> R.S. Rao	1	globose	Brown	Smooth/ coarsely reticulate	2×2	Nil

***Commelina appendiculata* C.B. Clarke:** Capsule 1 or 2 per spathe, ca. 10×4.5 mm, globose, trilocular, basal ventral ovules aborted, upper ventral ovules developing into seeds, dorsal locule indehiscent. Seeds oblong, 4.5-6×2.2-2.3 mm, testa brown, smooth, appendaged at both ends, white farinose, hilum linear, embryotega lateral (under LM).

**Specimens examined:** India, West Bengal, Darjeeling-Jowai, 13/06/1870, C.B. Clarke 12065 (CAL). Assam, Nonpogh, Amlighat, 22/08/1964, N.P. Balakrishnan 39386 (CAL).

***Commelina attenuata* Vahl (Fig. IA; Plate 1A, B):** Capsule 1 per spathe, ca. 4-6×3-4 mm, ovoid, bilocular,

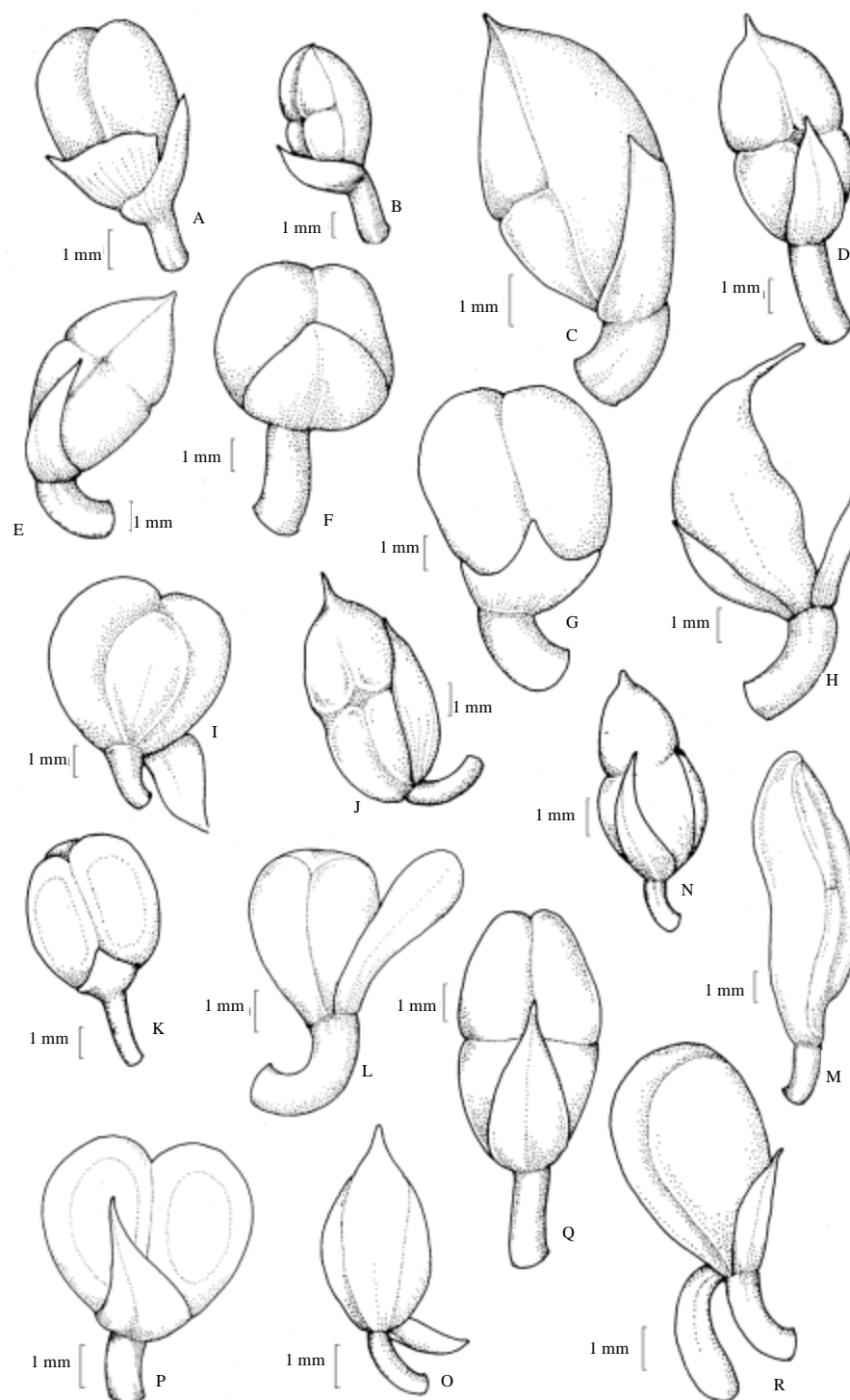


Fig. 1(A-R): Capsules of *Commelina*: (A) *Commelina attenuata*, (B) *C. benghalensis*, (C) *C. caroliniana*, (D) *C. clavata*, (E) *C. diffusa*, (F) *C. ensifolia*, (G) *C. forskalaei*, (H) *C. indehiscens*, (I) *C. kurzii*, (J) *C. longifolia*, (K) *C. maculata*, (L) *C. paludosa*, (M) *C. petersii*, (N) *C. sikkimensis*, (O) *C. subulata*, (P) *C. suffruticosa*, (Q) *C. tricolor* and (R) *C. wightii*

dorsal locule aborted, ventral locules 1 seeded. Seeds elliptic, appendaged at both end, 3×1 mm, testa dark brown, smooth under LM and reticulate under SEM with farinose granules, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Alappuzha district, Pathiramanal, 30/07/2003, Aneesha T.H.5150; Kozhikode district, Thikkodi, 30/08/2002, Santhosh Nampy and Joby 478; Thiruvananthapuram district, Veli, 11/10/2009, Sheba and Santhosh Nampy 2281 (DEV).

***Commelina benghalensis* L. (Fig. 1B; Plate 1C, D):** Capsule 1 per spathe, 5-6×3-4 mm, oblong-elliptic, trilocular, dorsal locule 1 seeded, ventral locules 2 seeded. Seeds ovoid, 2×1.5 mm, testa black-brown, furrowed reticulate with white farinose, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Kozhikode district, Devagiri, 10/10/2001, Santhosh Nampy 141; Ambumala, 12/12/2001, Santhosh Nampy 190 (DEV). Maharashtra. Kholapur district, Ajantha Caves, 03/09/2010, Santhosh Nampy and Sheba 4280 (DEV).

***Commelina caroliniana* Walter (Fig. 1C; Plate 1E, F):** Capsule 1 or 2 per spathe, 5-6×2-3 mm, ovate-elliptic, trilocular, dorsal locule 1 seeded, ventral locules 2 seeded. Seeds ovate-pyriform, ca. 3×2 mm, truncate at one end, sub-acute at the other end, testa dark brown, smooth, white farinose, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Wayanad district, Kabani Riverside, 30/11/2002, Joby and Santhosh Nampy 5103 (DEV). Maharashtra. Pune, Bhosari, 05/09/2010, Sheba and Santhosh Nampy 3273 (DEV). Goa. Panaji, 29/09/2002, Joby and Santhosh Nampy 841 (DEV).

***Commelina clavata* C.B. Clarke (Fig. 1D; Plate 1G, H):** Capsule 2-3 per spathe, 8-9×4.5-6 mm, oblong-elliptic, compressed, bilocular, dorsal locule absent, ventral locules 2 seeded. Seeds elliptic, 2.5-3×2-2.2 mm, testa dark brown, shallowly reticulate, hilum linear and embryotega lateral.

**Specimens examined:** India, Kerala, Wayanad district, Chembra, 26/11/2003, Joby and Santhosh Nampy 874; Vythiri, 19/01/2010, Sheba and Santhosh Nampy 3214; Idukki district, Vagamon, 07/12/2010, Sheba and Shahina 4026 (DEV).

***Commelina coelestis* Willd.:** Capsule 3 or 4 per spathe, 6-7.5×4 mm, oblong, trilocular, dorsal locule 1 seeded, ventral locules 2 seeded. Seeds triangular, ca. 3.4×2.3 mm,

testa brown or black, pitted, hilum linear, embryotega lateral (under LM).

**Specimens examined:** India, Tamil Nadu, Nilgiri, Ootty, 07/1883, unknown s.n (MH); Sikkim, 13/08/1875, G. King 2239 (CAL).

***Commelina diffusa* Burm.f. (Fig. 1E; Plate 2A, B):** Capsule 1-3 per spathe, 8-9×4-5 mm, oblong, trilocular, dorsal locule 1 seeded, ventral locules 2 seeded. Seeds oblong, ca. 4×2 mm, testa brown, doubly reticulate, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Kozhikode district, Palazhi, 12/02/2003, Joby and Aneesha 95; Thamarassery, 18/07/2010, Sheba and Santhosh Nampy 3240 (DEV). Meghalaya. Way to Jowai, 09/09/2009, Sheba and Santhosh Nampy 2275 (DEV).

***Commelina ensifolia* R. Br. (Fig. 1F; Plate 2C, D):** Capsule 1-2 per spathe, 5-6×4-5 mm, elliptic-obovoid, bi or trilocular, rarely dorsal locule absent, ventral locules 1 seeded. Seeds ovoid, 2.5-3.5×2-3 mm, testa mottled light and dark brown, smooth under LM and coarsely reticulate under SEM, a torus of soft whitish brown material around the periphery, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Thiruvananthapuram district, Museum, 05/11/2010, Sheba and Santhosh Nampy 4006; Kozhikode district, Devagiri Botanical garden, 04/06/2010, Sheba and Santhosh Nampy 3234 (DEV). Tamil Nadu. Nilgiri, Naduvattom, 20/11/01, Santhosh Nampy 177 (DEV).

***Commelina forskalaei* Vahl (Fig. 1G; Plate 2E, F):** Capsule 1 per spathe, 5-6×3.5-4 mm, obovoid, trilocular, dorsal locule 1 seeded ventral locule 2 seeded. Seeds globose, ca. 2.5×2 mm, testa brown, smooth under LM and coarsely reticulate under SEM, hilum linear, embryotega lateral. Capsules of cleistogamous flowers 1 or 2 seeded, indehiscent. Seeds smooth with furrows and ridges.

**Specimens examined:** India, Kerala, Kozhikode district, Nandi, 03/08/2002, Joby and Santhosh Nampy 483 (DEV). Karnataka. Mysore, 04/10/2001, Santhosh Nampy 138; 06/06/2010, Sheba and Santhosh Nampy 3235 (DEV).

***Commelina indehiscens* E. Barnes (Fig. 1H; Plate 2G, H):** Capsules 1-3 per spathe, 1-1.2×0.3-0.4 cm, oblong, trilocular, indehiscent, laterally compressed, dorsal locule 1 seeded, ventral locules aborted. Seeds ovoid, 6.5×2 mm, testa black-dark brown with light brown reticulations, hilum linear, embryotega lateral.

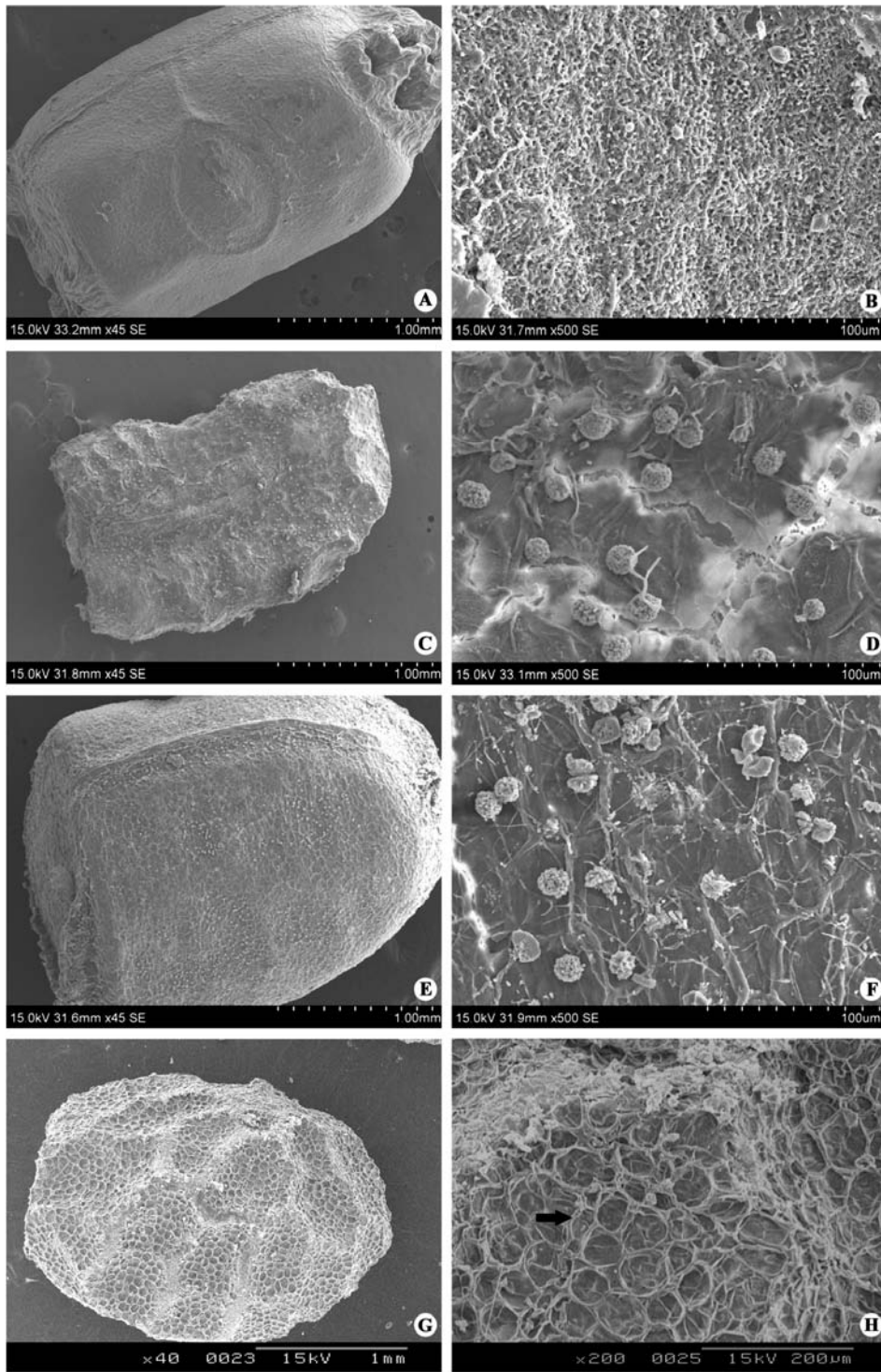


Plate 1: (A-B) *Commelina attenuata* Vahl, (C-D) *C. benghalensis* L., (E-F) *C. caroliniana* Walter, (G-H) *C. clavata* C.B. Clarke

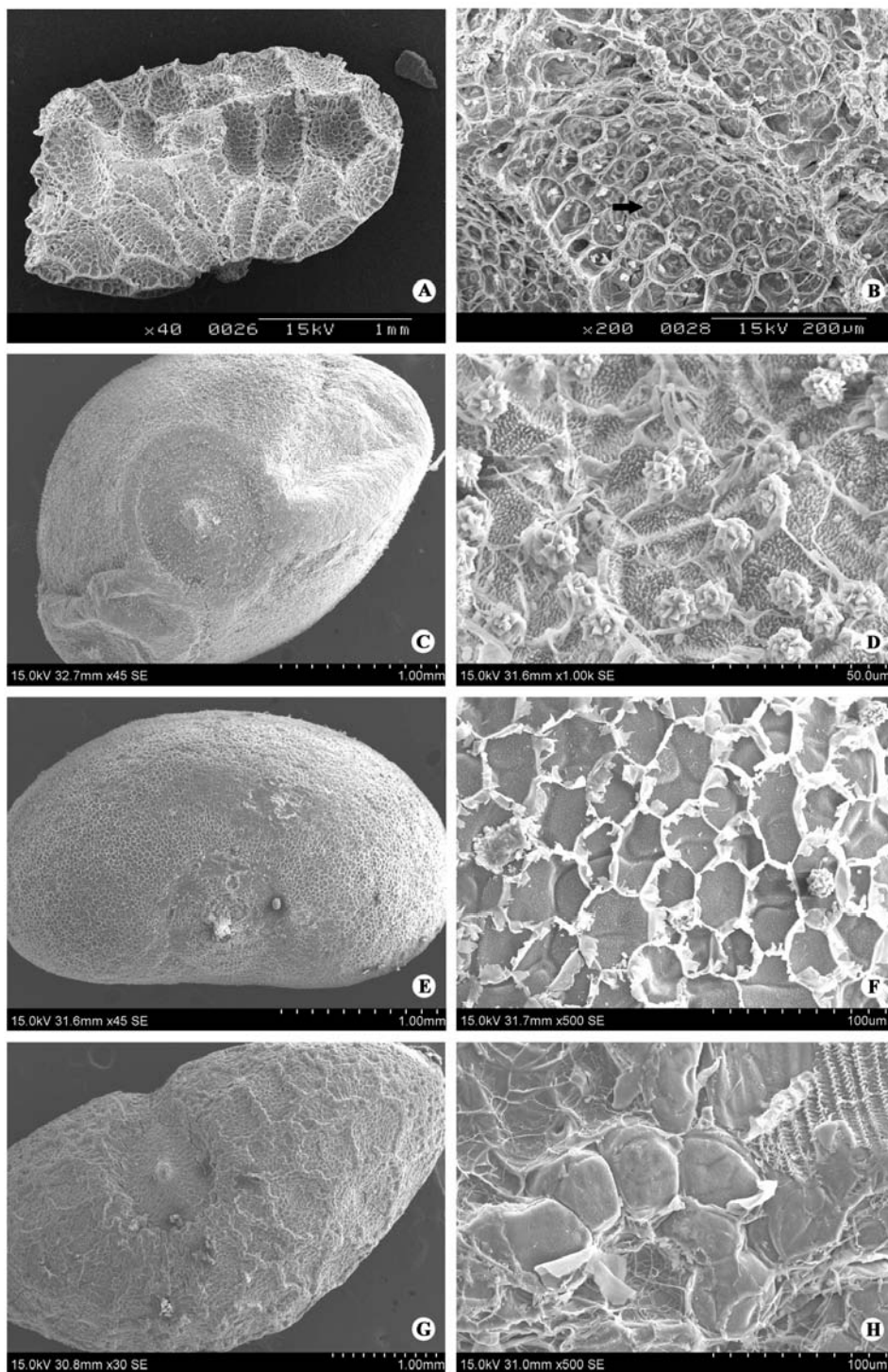
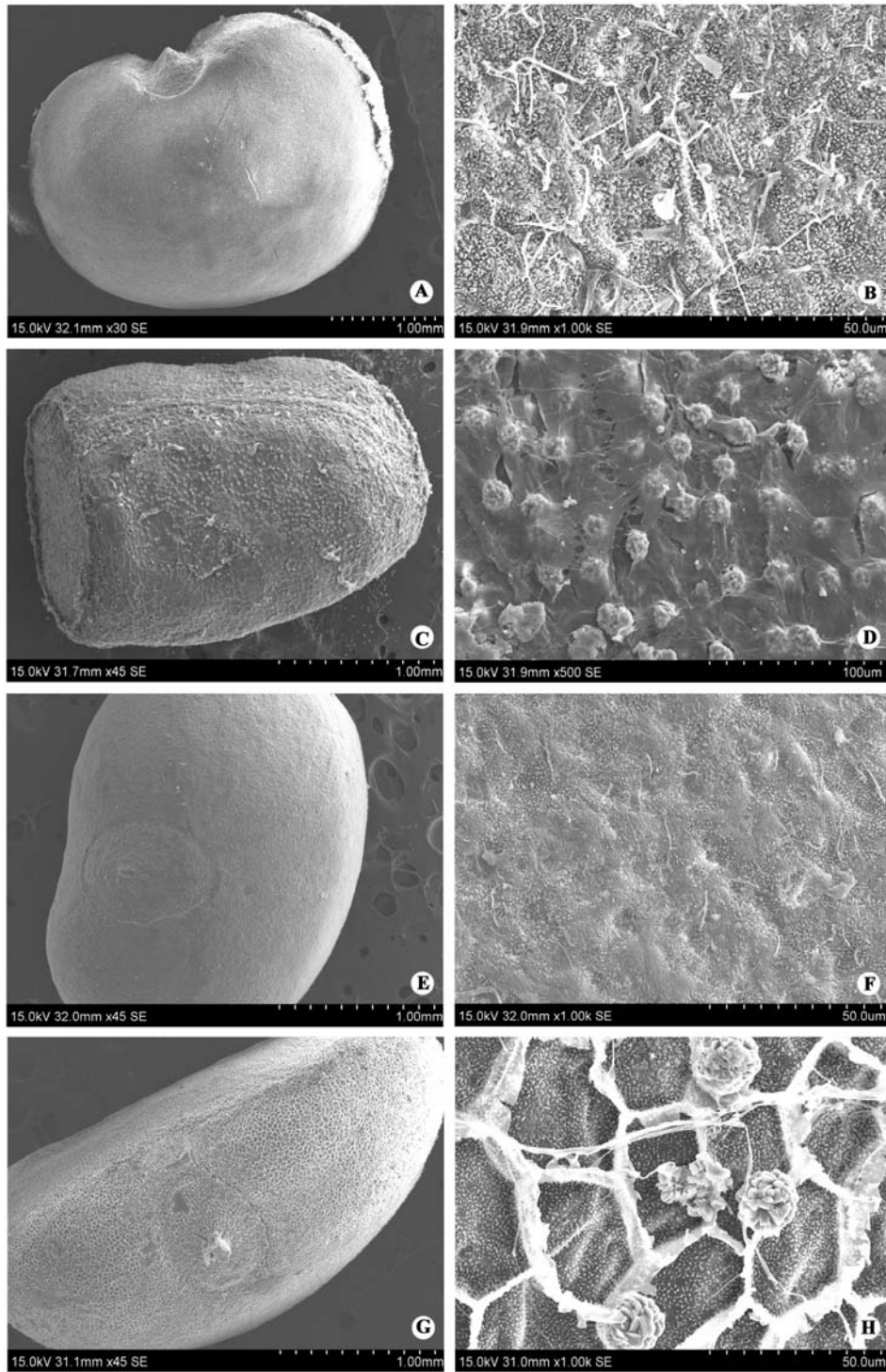


Plate 2: (A-B) *Commelina diffusa* Burm.f., (C-D) *C. ensifolia* R. Br., (E-F) *C. forskalaei* Vahl, (G-H) *C. indehiscens* E. Barnes





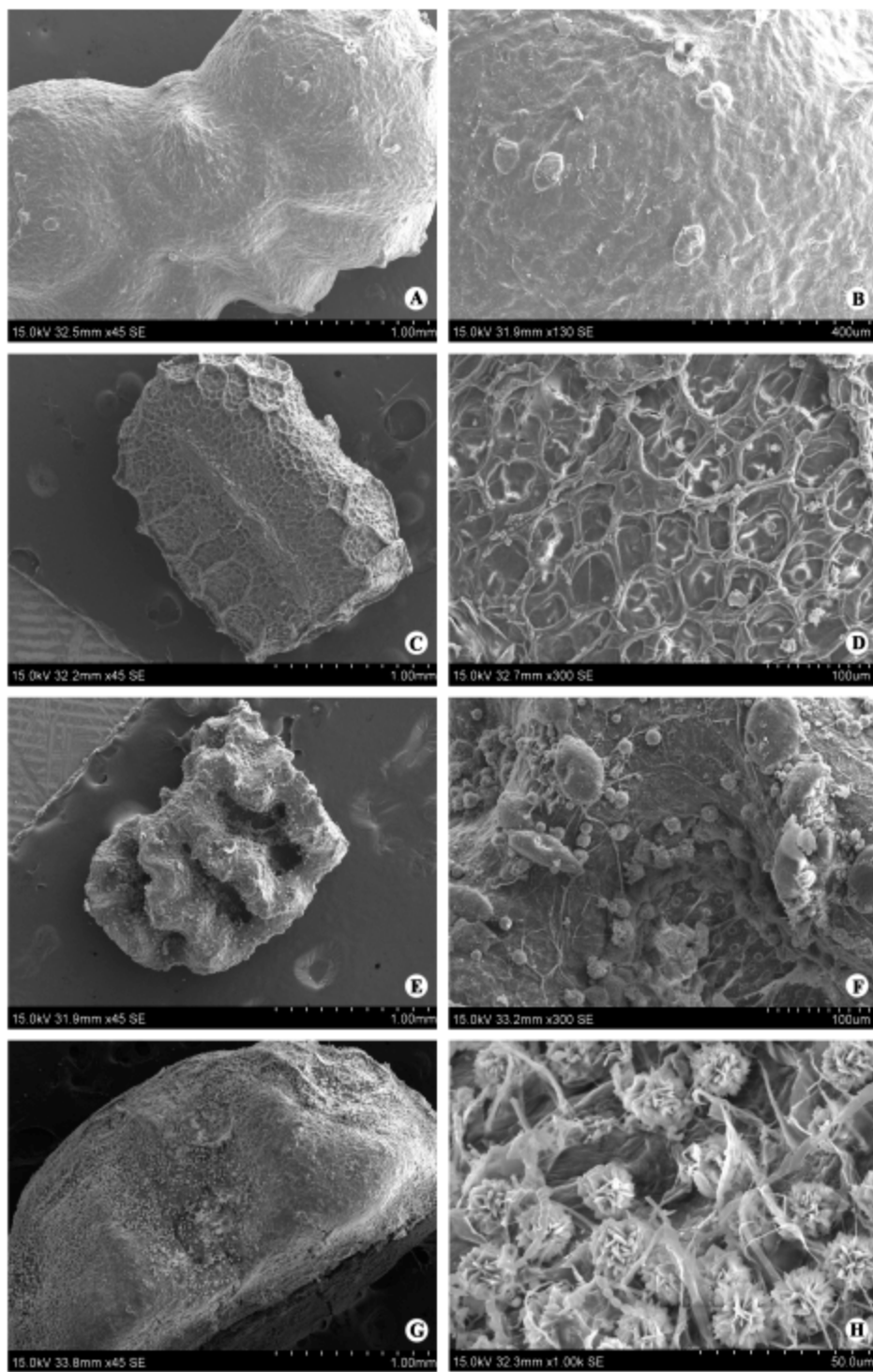
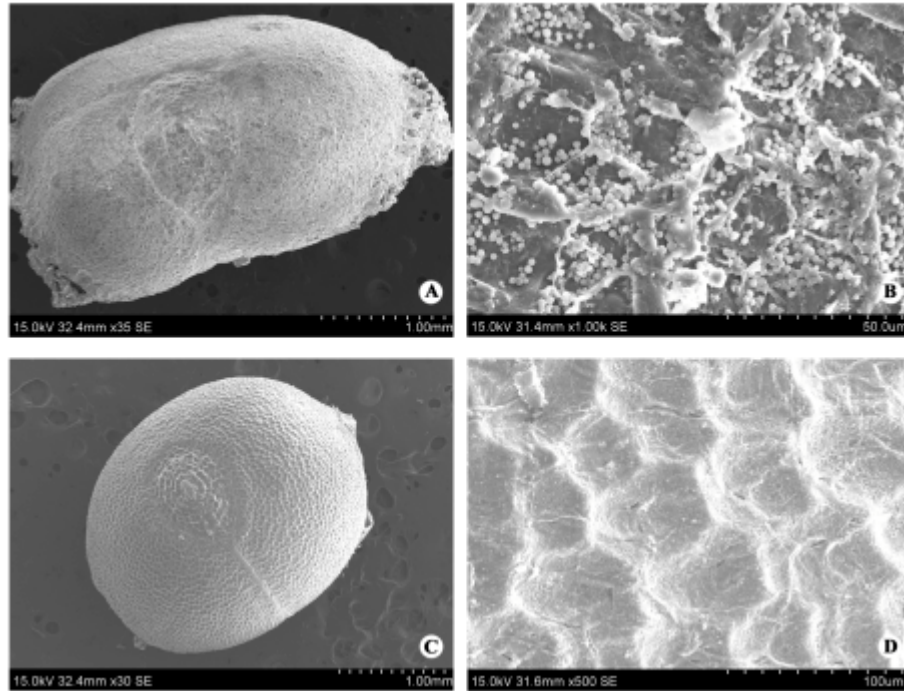


Plate 4: (A-B) *Commelina petersii* Hassk., (C-D) *C. sikkimensis* C. B. Clarke, (E-F) *C. subulata* Roth, (G-H) *C. suffruticosa* Blume



**Plate 5:** (A-B) *Commelina tricolor* E. Barnes, (C-D) *C. wightii* R.S. Rao

**Specimens examined:** India, Kerala, Idukki district, Adimali, 19/11/2010, Sheba and Santhosh Nampy 4015, Wayanad district, Ambalavayal, 20/06/2009, Sheba and Santhosh Nampy 3205 (DEV).

***Commelina kurzii* C. B. Clarke (Fig. 1I; Plate 3A, B):** Capsule 1 or 2 per spathe, 7-8×5-6 mm, globose, trilocular, locules 1 seeded, rarely dorsal locule aborted. Seeds ovate, ca. 3×2 mm, testa brown, smooth, torus of brown material around the periphery, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Thrissur district, Vazhani forest, 15/08/2003, Aneesha and Joby 939; Wadakkancherry, 10/12/2010, Shahina and Sheba 4050; Palakkadu district, Nelliampathy, 12/12/2002, Joby and Santhosh Nampy 5115 (DEV). Tamil Nadu, Tirunelvely, Courtallum, 11/09/2003, Joby and Santhosh Nampy 969 (DEV).

***Commelina longifolia* Lam. (Fig. 1J; Plate 3C, D):** Capsule 1 or 2 per spathe, 8-9×3-4 mm, oblong, trilocular, dorsal locule 1 seeded, ventral locules 2 seeded. Seeds ovoid, ca. 3×2 mm, testa brown, smooth with white farinose, whitish appendage at the rounded end, hilum linear, embryotega lateral.

**Specimen examined:** India, Maharashtra, Pune, Nigdi, 03/09/2010, Sheba and Santhosh Nampy 3264 (DEV).

***Commelina maculata* Edgew. (Fig. 1K; Plate 3E, F):** Capsule 1 or 2 per spathe, 6-7×5 mm, ovoid, trilocular, locules 1 seeded. Seeds oblong, ca. 3×2 mm, testa reddish brown, smooth, hilum linear, embryotega lateral.

**Specimens examined:** India, Meghalaya, Shillong, Moplangh, 08/09/2009, Sheba and Santhosh Nampy 2269; Shillong, 08/09/2009, Sheba and Santhosh Nampy 2266, 2267 (DEV).

***Commelina paleata* Hassk.:** Capsule 1 or 2 per spathe, ca. 6×4 mm, oblong, trilocular, locules 1-seeded. Seeds oblong, 3×1 mm, testa dark brown, smooth with white farinose, hilum linear, embryotega lateral (Under LM).

**Specimen examined:** India, Maharashtra, Thane, Vanderodi, 19/09/1968, K.V. Billore 116770 (CAL). Tamil Nadu, Salem, Hogainakkal, 12/07/1964, E. Vajravelu 20580 (MH).

***Commelina paludosa* Blume (Fig. 1L; Plate 3G, H):** Capsule 1-3 per spathe, 4×3 mm, obovoid, trilocular, locules equal, 1 seeded. Seeds ellipsoid, 3-4×2.5 mm, testa

dark brown, smooth under LM and coarsely reticulate under SEM, minutely white farinose, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Kannur district, Kottiyoor, 01/10/2003, Joby and Santhosh Nampy 998; Kozhikode, district, Devagiri Botanical Garden, 03/01/2011, Sheba and Santhosh Nampy 4035; Muthappanpuzha, 25/02/2001, Santhosh Nampy 566; Ambumala, 12/12/2001, Santhosh Nampy 186 (DEV).

***Commelina petersii* Hassk. (Fig. 1M; Plate 4A, B):** Capsule 1 or 2 per spathe, 9-10×3-4 mm, ovate elliptic, compressed, trilocular or bilocular, dorsal locule 1 seeded, rarely absent, ventral locules 2 seeded. Seeds ovate-pyriform, 1.75×1 mm, testa dark brown, mottled with black, 3-6 transverse furrows, the intervening ridges with 2-many white-light brown tubercles, hilum linear, embryotega lateral.

**Specimens examined:** Kerala. Kozhikode district, Devagiri Botanical Garden, 07/06/2009, Sheba and Santhosh Nampy 3201 (DEV). Tamil Nadu. Coimbatore, 27/11/2010, Sheba and Santhosh Nampy 3973; Gudallur, 20/11/2001, Santhosh Nampy 580 (DEV).

***Commelina sikkimensis* C.B. Clarke (Fig. 1N; Plate 4C, D):** Capsule 1 or 2 per spathe, 5-6×2-3 mm, oblong, trilocular, dorsal locule 1 seeded, ventral locules 2 seeded. Seeds ovoid-oblong, 3-4×2-3 mm, testa dark brown, reticulately pitted, hilum linear, embryotega lateral.

**Specimens examined:** India, Meghalaya, Jowai, 09/09/2009, Sheba and Santhosh Nampy 2271, 2276 (DEV).

***Commelina subulata* Roth (Fig. 1O; Plate 4E, F):** Capsule 2 per spathe, 4.5×2.5 mm, oblong, trilocular, dorsal locule 1 seeded, ventral locules 2 seeded. Seeds ovoid, compressed, ca. 2 mm, testa black, transversely pitted, white farinose, hilum linear, embryotega lateral.

**Specimen examined:** India, Andhra Pradesh, Chittoor district, Horsely hill, 19/10/2004, Joby and Ratheesh 1152 (DEV).

***Commelina suffruticosa* Blume (Fig. 1P; Plate 4G, H):** Capsule 5 or 6 per spathe, ca. 5×5 mm, globose, trilocular, dorsal locule aborted, ventral locules 1 seeded. Seeds elliptic 3×2 mm, testa dark brown, foveate reticulate, white farinose, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala, Pathanamthitta district, Elimullu, 31/05/2010, Sheba and Santhosh Nampy 3232; Thrissur district, Athirappally, 16/08/2003, Aneesha and Joby 946; Wayanad district, Muthanga, 25/08/2002, Dineshraj and Santhosh Nampy 824 (DEV).

***Commelina tricolor* E. Barnes (Fig. 1Q; Plate 5A, B):** Capsule 1 or 2 per spathe, 9-10×3-3.5 mm, ovoid-oblong, compressed, bilocular, dorsal locule absent, ventral locules 2 seeded. Seeds ovoid-oblong, 4×1.5 mm, testa pale brown, smooth with farinose granules, hilum linear, embryotega lateral.

**Specimens examined:** India, Kerala. Wayanad district, Muthanga, 29/11/2002, Joby and Santhosh Nampy 891 (DEV). Tamil Nadu. Needle point, 06/10/2002, Nisha and Dineshraj 847; 25/10/2003, Joby and Santhosh Nampy 5178; 26/09/2010, Sheba and Santhosh Nampy 3485 (DEV).

***Commelina wightii* R.S. Rao (Fig. 1R; Plate 5C, D):** Capsule 1 per spathe, 5-5.5×3.5-4 mm, globose, dorsal locule and 1 ventral locule aborted, 1 ventral locule 1 seeded. Seed globose, 2×2 mm, testa brown, smooth under LM, coarsely reticulate under SEM, hilum linear, embryotega lateral.

**Specimen examined:** India, Kerala, Kozhikode district, Devagiri Botanical Garden, 27/10/2010, Sheba and Santhosh Nampy 3292; Thrissur district, Brahmakulam, 09/08/2010, Alfred and Shahina 3253 (DEV).

## DISCUSSION

The capsule and seed morphology of 22 Indian species *Commelina* are investigated. They provide taxonomically useful characters for species delimitation.

The size of the capsule varies from 4-10×2-6 mm. The longest capsule is found in *C. appendiculata* and *C. indehiscens* and the smallest in *C. subulata*. The tip of the capsule is long and pointed in *C. indehiscens*.

The shape of the capsule varies from globose, ovoid, obovoid, oblong to elliptic. Globose capsules are found in *C. kurzii*, *C. wightii*, *C. appendiculata* and *C. suffruticosa*. In *C. albescens*, *C. maculata* and *C. attenuata*, the capsules are ovoid while in *C. paludosa* and *C. forskalaei* the capsules are obovoid. Capsules are ovate-elliptic in *C. petersii* and *C. caroliniana* but in *C. clavata*, it is oblong-elliptic. It is obovoid elliptic in *C. ensifolia* and ovoid-oblong in *C. tricolor*. All the others are with oblong capsule.

The capsules are either 1 or 2 within a spathe generally but it is always one in *C. attenuata*, *C. benghalensis*, *C. forskalaei* and *C. wightii*. It is always two in *C. subulata*, 3 or 4 in *C. coelestis* and 5 or 6 in *C. suffruticosa*.

The capsule is trilocular in most species, but it is bilocular in *C. clavata*, *C. suffruticosa*, *C. tricolor* and *C. attenuata*. Only one locule is functional in *C. wightii* due to the abortion of the dorsal and one of the ventral locule. In *C. kurzii*, *C. ensifolia*, *C. petersii* and *C. albescens*, the second flower produces bilocular capsule.

The two ventral locules are 2 seeded usually, but they are aborted in *C. indehiscens*. In *C. wightii* one of the ventral locule is aborted while the other is 1 seeded. In *C. ensifolia*, *C. maculata*, *C. paludosa*, *C. suffruticosa*, *C. kurzii*, *C. appendiculata* and *C. paleata* the ventral locules are always one seeded.

The size of the seeds varies from 2-6×1-3 mm. Largest seed is in *C. appendiculata* and *C. indehiscens* and the smallest seed is found in *C. subulata*.

The seed also shows variation in shape, size, number, colour of the testa and ornamentation. The seed is triangular in *C. coelestis*, ovoid-oblong in *C. sikkimensis* and *C. tricolor*, globular in *C. forskalaei*, *C. wightii* and *C. albescens*, elliptic in *C. attenuata*, *C. suffruticosa*, *C. paludosa* and *C. clavata*, ovoid in *C. benghalensis*, *C. ensifolia*, *C. indehiscens*, *C. longifolia*, *C. subulata* and *C. kurzii*, oblong in *C. diffusa*, *C. maculata* and *C. paleata* and ovate-pyriform in *C. caroliniana* and *C. petersii*.

The ornamentation of the seed surface under LM is smooth, reticulate, pitted or ridged. At SEM, the surface is granulate, rugulate, reticulate or perforate with or without farinose granules. The surface is irregularly pitted in *C. coelestis*, transversely pitted in *C. subulata*, reticulately pitted in *C. sikkimensis*. In *C. petersii* the surface with tubercles on ridges and in *C. benghalensis* shows furrowed reticulations. The seed of *C. suffruticosa* is foveate reticulate, *C. clavata* is shallowly reticulate and *C. diffusa* is doubly reticulate. In all the other species the surface is smooth.

Farinose granules are absent in *C. coelestis*, *C. kurzii*, *C. wightii*, *C. sikkimensis*, *C. indehiscens*, *C. forskalaei*, *C. clavata* and *C. petersii*. In all others, the farinose granules are scattered in different manner. It may be thickly arranged or irregularly scattered. Comparatively larger farinose outgrowths are seen in *C. ensifolia*, *C. maculata*, *C. paludosa* and *C. suffruticosa*.

The seeds are appendaged at both ends in *C. appendiculata* and *C. attenuata* and single appendaged in *C. longifolia*. The appendages are honey comb like in *C. attenuata*. Tubercles are found through the ridges in *C. petersii*. In all Indian species studied, the hilum is linear and the embryotegea is lateral.

### KEY TO THE SPECIES

1 Seeds ridged	2
1 Seeds not ridged	3
2 Seeds with tubercles on the ridges	<i>C. petersii</i>
2 Seeds without tubercles	<i>C. benghalensis</i>
3 Seeds pitted	4
3 Seeds not pitted	6
4 Seeds irregularly pitted	<i>C. coelestis</i>
4 Seeds regularly pitted	5
5 Seeds transversely pitted	<i>C. subulata</i>
5 Seeds reticulately pitted	<i>C. sikkimensis</i>
6 Seeds reticulate	7
6 Seeds smooth	10
7 Capsule single seeded	<i>C. indehiscens</i>
7 Capsule many seeded	8
8 Seeds doubly reticulate	<i>C. diffusa</i>
8 Seeds not doubly reticulate	9
9 Seeds shallowly reticulate, 4 seeded	<i>C. clavata</i>
9 Seeds foveately reticulate, 2 seeded	<i>C. suffruticosa</i>
10 Seeds appendaged	11
10 Seeds not appendaged	13
11 Seed appendage at both ends	12
11 Seed appendage at one end	<i>C. longifolia</i>
12 Capsule 3 seeded	<i>C. appendiculata</i>
12 Capsule 2 seeded	<i>C. attenuata</i>
13 Capsule 1 seeded	<i>C. wightii</i>
13 Capsule more than 1 seeded	14
14 Capsule 3 seeded	15
14 Capsule more than 3 seeded	19
15 Presence of torus on the surface	16
15 Absence of torus on the surface	17
16 Torus material brown	<i>C. kurzii</i>
16 Torus material white	<i>C. ensifolia</i>
17 Seed testa reddish brown	<i>C. maculata</i>
17 Seed tests dark brown	18
18 Seeds oblong	<i>C. paleata</i>
18 Seeds ovoid	<i>C. paludosa</i>
19 Capsule 4 seeded	20
19 Capsule 5 seeded	21
20 Seeds oblong	<i>C. tricolor</i>
20 Seeds globose	<i>C. albescens</i>
21 Seed spherical	<i>C. forskalaei</i>
21 Seed sub-acute at one end	<i>C. caroliniana</i>

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