



Casearia seethalakshmia (Samydoideae, Salicaceae), a new species from Palakkad Gap, Kerala (India)

VISWANATHANPILLAI AMBIKA^{1,3}, JOSE SOJAN^{2,4} & VEERANKUTTY SURESH^{1,5,*}

¹Department of Botany, Government Victoria College, Palakkad, Kerala- 678001, India

²Department of Botany, Government College Chittur, Palakkad, Kerala- 678104, India

³✉ ambikameenu123@gmail.com; <https://orcid.org/0000-0002-6807-0991>

⁴✉ sojanchakkalackal@gmail.com; <https://orcid.org/0000-0002-9763-9251>

⁵✉ sureshmagnolia@gmail.com; <https://orcid.org/0000-0001-7350-9236>

*Author for correspondence

Abstract

Casearia seethalakshmia, a new species from India, is described and compared with the three other currently accepted Indian species namely *C. graveolens*, *C. glomerata*, and *C. bourdillonii*. The new species belongs to the *Casearia* sect. *Casearia*, and is confined to Palakkad, Kerala. Detailed description, distribution, phenology, photographs and a key to the species of Indian *Casearia* are provided.

Keywords: Flora, Salicales, Samydoeae, Taxonomy

Introduction

The Salicaceae is a pantropical family with 3 subfamilies including 1010 species and 55 genera (APG IV 2016). Among them, *Casearia* Jacquin (1760: 21) is the most representative genus with about 215 species of shrubs or trees and a centre of diversity in the tropics and subtropics of the American continent (Sleumer 1980, Marquete & Mansano 2016, Mabberley 2017, Nepomuceno & Alves 2017). Formerly it had been included in the family Flacourtiaceae (Castillo-Campos & Abreo 2003), whose genera and species were split into three families, Achariaceae, Lacistemataceae and Salicaceae (Chase *et al.* 2002). At present, the genus belongs to the family Salicaceae, subfamily Samydoideae and tribe Samydoeae (Byng 2014, Samarakoon 2015, APG IV 2016). The genus *Casearia* consists of shrubs to medium-sized trees and can be distinguished by the presence of axillary fascicles or glomerules (rarely cymes) of non-showy, small green flowers; single row of stamens alternating with staminodes; showy fruits and brightly coloured arillate seeds (Sleumer 1980). It is distributed throughout the tropics, including Asia and the Pacific Islands (about 98 spp.), North and South America (about 75 spp.), Africa, Madagascar, and the Indian Ocean islands (16 spp.), and Australia (5 spp.). They are common elements in the moist deciduous forests and plains of the tropics (Gentry 1993).

Due to the large number of species, wide distribution of the genus, importance of small morphological features in classification, keying and species delimitation, no worldwide treatment of *Casearia* has been completed. Hermann Sleumer completed taxonomic treatments of *Casearia* species of Africa, Madagascar, Neotropics, Australia, and Malesia (Sleumer 1954, 1956, 1971, 1980, 1985). Roxburgh (1832) recognized nearly half of the *Casearia* species (six species) currently known in India. A taxonomic revision of *Casearia* in south-central Asia, including the area from Pakistan to Burma and south from the Himalayas to Sri Lanka recognized thirteen species of this genus. Among them, nine species are endemic to south-central Asia and four are more widespread to south-east Asia, China and Malesia (Samarakoon 2015).

Material and methods

The new species was found during the field trips carried out in the Palakkad district of Kerala. Herbarium materials of the genus were studied at CALI, JCB, K, MH and MO (acronyms according to Thiers 2022).

Taxonomic treatment

Casearia seethalakshmia V. Suresh & Ambika sp. nov. (Figs. 1 & 2)

Casearia seethalakshmia is morphologically distinguished from its allied spp. (*C. graveolens*, *C. glomerata* and *C. bourdillonii*) by being a small shrubs of 1–1.5 m height, presence of prominent pellucid dots and streaks on leaf lamina, petiole 5–10 mm long, stipule dimorphic and both densely pubescent, and glabrous filaments. A comparison of the new species with its allied *C. graveolens*, *C. glomerata* and *C. bourdillonii* is given in Table 1.

TABLE 1. Morphological comparison of *C. seethalakshmia* with *C. graveolens*, *C. glomerata* and *C. bourdillonii*.

Characters	<i>C. graveolens</i>	<i>C. glomerata</i>	<i>C. bourdillonii</i>	<i>C. seethalakshmia</i>
Plant height	small to medium-sized shrubs 2–3 m or small trees 3–15 m height.	Large shrub or small to medium sized tree, 2–15 m height.	small to medium-sized shrubs 2–3 m or small trees 3–15 m height	small shrubs of 1–1.5 m height
Twigs	young shoots glabrous	young shoots pubescent	young shoots glabrous	only very young shoots pubescent
Bud	glabrous	densely pubescent, hairs appressed	glabrous	densely pubescent
Lamina size	4–15.5 × 2.5–7.5 cm	4–12(–15) × 3–6.5(–8) cm	4–15.5 × 2.5–7.5 cm	6–25 × 3–5 cm
Leaf margin	shallowly serrate, crenate, very rarely repand	Serrulate or crenulate to nearly entire	entire	distantly crenulate
Leaf surface	glabrous, pellucid dots and streaks very small and faint	sparsely puberulous along midrib and secondary veins when young, translucent glands elongate and round	glabrous, pellucid dots and streaks very small and faint	puberulous along midrib and secondary veins when tender, pellucid dots and streaks on lamina prominent
Lateral vein pairs	6–8	7–9	10–12	11–15
Petiole	6–20 mm long, and grooved above	8–12 mm long and grooved above	10–15 mm long and grooved above	5–10 mm long and slightly sunken above
Stipule	2.5 × 1.5 mm and glabrous	ca. 1 mm, adaxially sparsely appressed hairy, margin ciliate,	2.5 × 1.5 mm and glabrous	0.8–2 × 0.25–0.5 mm, dimorphic on either side of the petiole, larger spatulate and smaller conical, both densely pubescent.
Pedicele surface	glabrous both above and below articulation	both above and below articulation pubescent	glabrous both above and below articulation	glabrous
Calyx surface	outside pubescent or glabrescent, inside sparsely hairy, margin practically glabrous, not ciliate	outside sparsely pubescent except toward margin, inside glabrous or rarely sparsely hairy, margin minutely ciliate to nearly glabrous	glabrous on both surfaces, margin ciliate	glabrous on both surfaces
Filament surface	pubescent	pubescent	pubescent	glabrous
Staminode surface	villous at the apex	apex densely hairy	villous at the apex	pubescent
Ovary surface	glabrous	glabrous or sparsely hairy near the style	glabrous	pubescent on upper part of the ovary
Fruit colour	orange-yellow	bright yellow	orange-yellow	pale green-yellow
Seeds	mostly globose but flattened on one side, aril dark scarlet	ovoid to round, aril orange scarlet	mostly globose but flattened on one side, aril dark scarlet	ovoid, variously crumpled

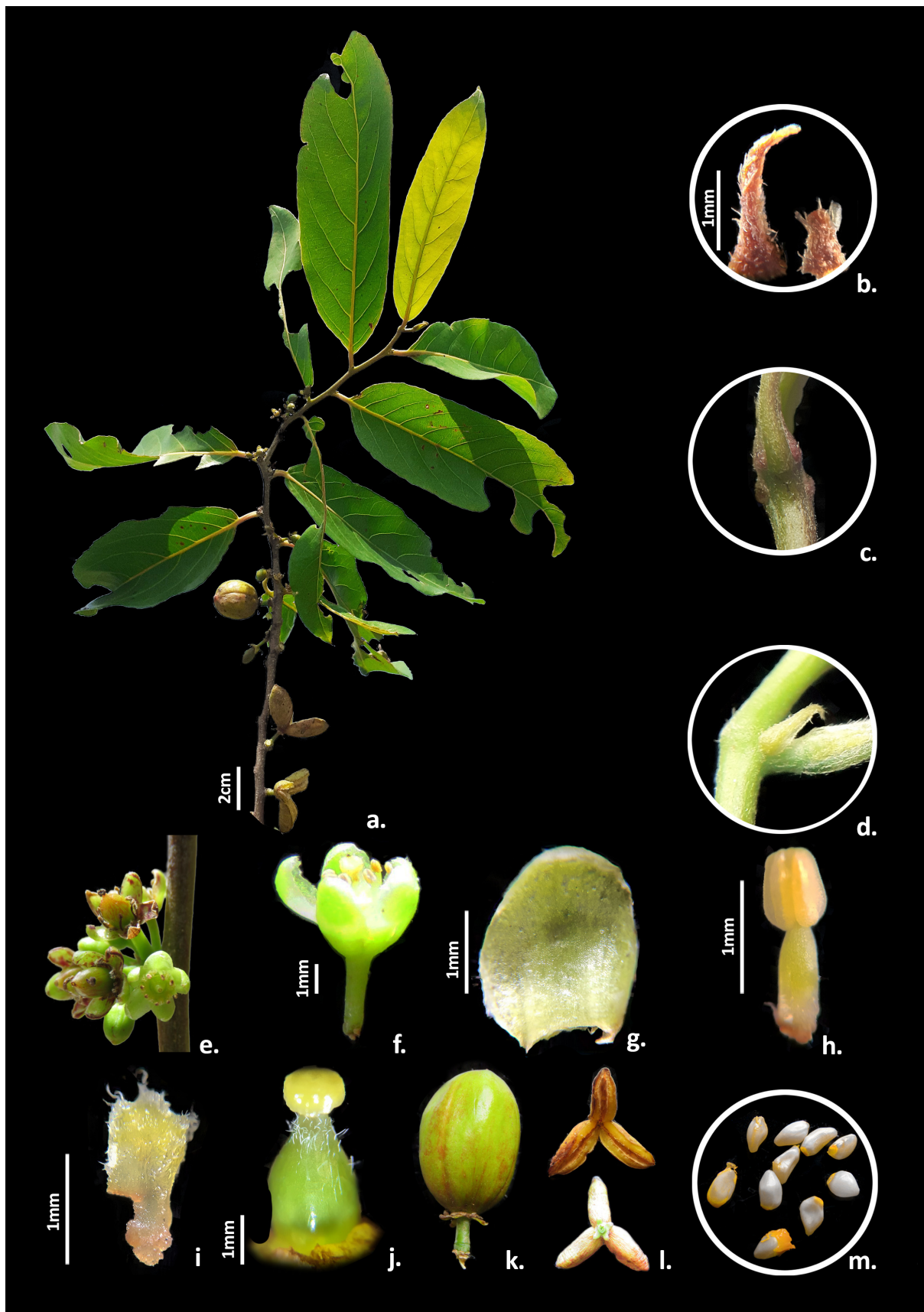


FIGURE 1. *C. seethalakshmia* a. branch with fruits; b. stipules; c. portion of young shoot showing stipules; d. base of young leaf with stipule; e. inflorescence; f. flower; g. internal surface of sepal; h. stamen; i. staminode; j. pistil; k. fruit with pedicel; l. dehiscent fruits, ventral and dorsal view; m. seeds

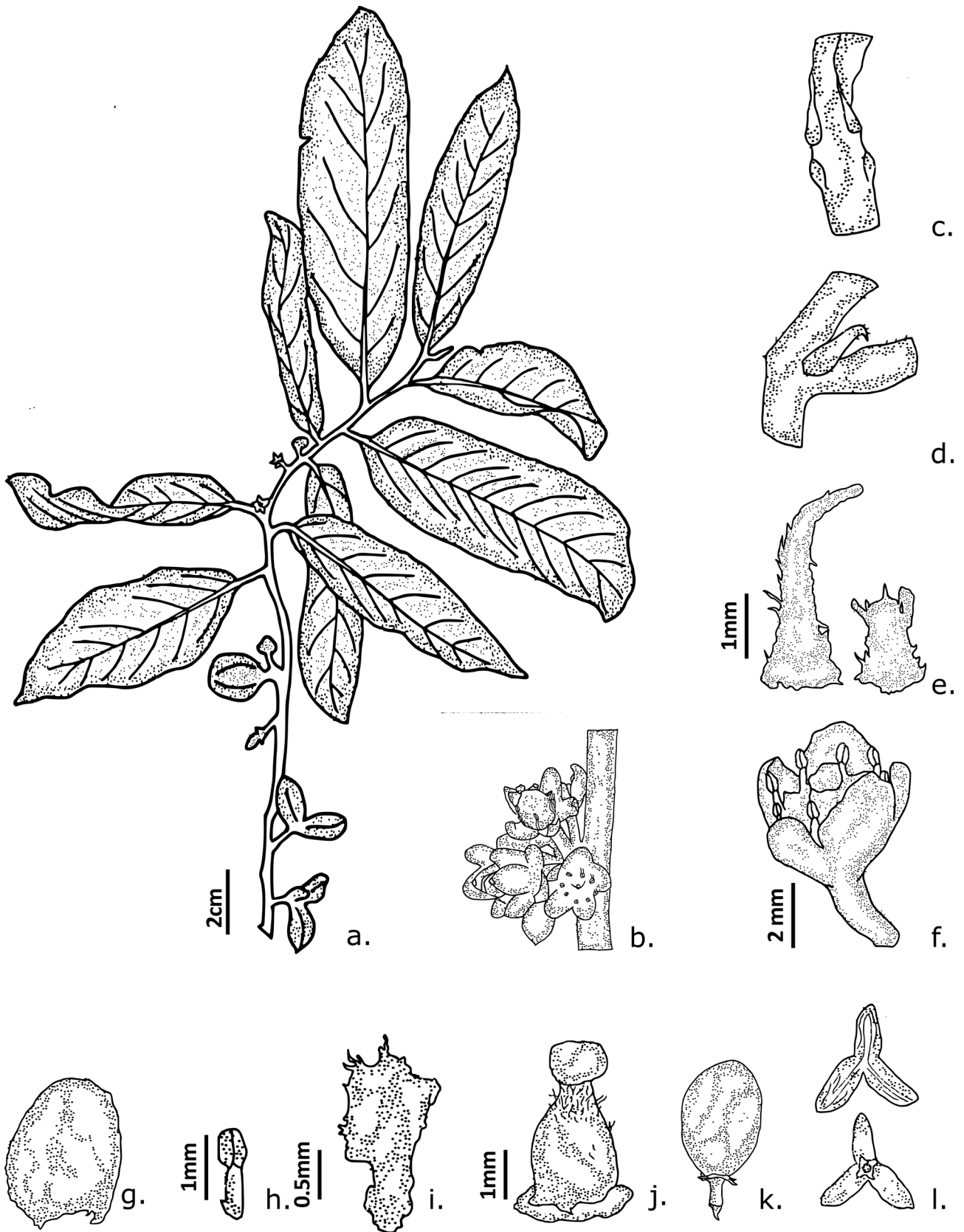


FIGURE 2. *C. seethalakshmiae* a. floral branch; b. inflorescence; c. young shoot; d. base of young leaf with stipule; e. stipules; f. flower; g. internal face of the sepal; h. stamen; i. staminode; j. carpel; k. fruit; l. dehiscent fruit ventral and dorsal view

Type:—INDIA. Kerala: Palakkad District, Kannadi-II, Uppumpadam Road, 85 m, 10°44'54.5"N, 76°40'16.4"E, 20 April 2021, V. Suresh & Ambika GVCP-SV 624 (Holotype: MH!; Isotype: UCBD!).

Description:—Small shrubs of 1–1.5 m height, bark grey, very young shoots pubescent and young buds densely pubescent. Leaves simple, alternate, blade elliptic-oblong or oblanceolate, 6–25 × 3–5 cm, coriaceous, apex acute-acuminate, base acute to cuneate, margin distantly crenulate, puberulous along midrib and secondary veins when tender, glabrous on abaxial and adaxial sides, midrib green, lateral nerves 11–15 pairs, pinnate, prominent on abaxial surface of leaf lamina, glabrous, intercostal tertiary veins reticulate, pellucid dots and streaks on lamina prominent. Petiole 5–10 mm long, puberulous, slightly sunken above. Stipules small, ovate-lanceolate, 0.8–2 × 0.25–0.5 mm, dimorphic on either side of the petiole, larger spatulate and smaller conical, both densely pubescent on adaxial surfaces. Inflorescence axillary fascicles, with ca. 8 flowers. Bracts minute, triangular, 2 mm long, pubescent, caducous. Pedicels 3 mm long, 1 mm diameter, glabrous. Flowers regular, bisexual, 4 mm long, 3 mm across, greenish. Calyx 5, free, imbricate, lobes ovate, 2.5 × 1.5 mm, green, glabrous on both sides. Petals 0. Stamens 6–9, united into a ring, alternating with equal number of staminodes in the ring, staminodes half the length of stamens, fleshy, pubescent. Filaments stout, glabrous, 1 mm long, anthers bilobed, 0.7 × 0.4 mm. Ovary 1.5 mm long, 2 mm in diameter, pubescent on the upper part; ovules 8–12 per ovary, > 0.08 mm long; style about 0.5 mm long, glabrous or sparsely hairy close to ovary, simple; stigma capitate, 1 mm in diam., obscurely lobed. Capsules obovoid, 2 × 1 cm, pale green to yellow when mature, glabrous, exocarp splitting to 3 valves of 2 mm thick, arils thick, Dark yellow to red, firm, enclosing the seeds, 8–12-seeded. Seeds ivory coloured, ovoid, variously crumpled.

Phenology:—Flowering in April; fruiting in May to June.

Habitat and distribution:—The species is found to grow in a riparian habitat along with *Phyllanthus reticulatus* Poiret. (1804: 298). Four populations of the species were recorded from Uppumpadam Road, Kannadi- II, Palakkad, Kerala. The associated taxa in the habitat include *Phyllanthus reticulatus*, *Croton bonplandianus* Baillon. (1864: 339), *Casearia graveolens* Dalzell (1852: 107) and *Calotropis procera* (Aiton) William Townsend Aiton (1811: 78).

Etymology:—The species is named after Dr. Seethalakshmi K.K, former scientist, KFRI, Kerala, India, in honor of her contributions in the field forestry research.

IUCN Conservation status:—The current study is based on two different populations ranging from 10–15 individuals. Further data is needed to determine the conservation status. Hence according to IUCN criteria, the new species is classified as DD (Data Deficient) (IUCN 2022).

Identification Key to Casearia in India.

- | | | |
|-----|---|---|
| 1. | Mature leaves pubescent or tomentose | 2 |
| 1. | Mature leaves glabrous or glabrescent | 5 |
| 2. | Filaments glabrous | <i>C. tomentosa</i> |
| 2. | Filaments hairy | 3 |
| 3. | Young shoot villous | <i>C. vareca</i> |
| 3. | Young shoots pubescent | 4 |
| 4. | Style 0.5 mm long | <i>C. kurzii</i> |
| 4. | Style 3 mm long | <i>C. wynadensis</i> |
| 5. | Fruit minutely, densely hairy with yellowish hairs | <i>C. zeylanica</i> |
| 5. | Fruit glabrous | 6 |
| 6. | Seeds variously crumpled, stipules dimorphic | <i>C. seethalakshmiae</i> |
| 6. | Seeds lacinate or striated, not crumpled, stipules monomorphic | 7 |
| 7. | Stipule margin ciliate | 8 |
| 7. | Stipule margin entire or smooth | 9 |
| 8. | Leaves blade translucent glands elongate and round | <i>C. glomerata</i> |
| 8. | Leaves blade pellucid glands punctate and striate | <i>C. grewifolia</i> var. <i>hexagona</i> |
| 9. | Staminodes densely pubescent | <i>C. graveolens</i> |
| 9. | Staminodes glabrous or tufted hairs at apex or margin ciliate | 10 |
| 10. | Fruit 2 valved | <i>C. thwaitesii</i> |
| 10. | Fruit 3 valved | 11 |
| 11. | Stamens 10, filaments glabrous or sparsely pubescent towards the base | <i>C. andamanica</i> |
| 11. | Stamens 8, filaments pubescent | <i>C. rubescens</i> |

Paratypes:—INDIA. Kerala: Palakkad District, Kannadi-II, near Nazeema Rice Mill, 86 m, 10°44'57.96"N, 76°40'15.78"E, 20 April 2021, *V. Suresh & Ambika GVCP-SV 625*; near Al Ameen Fisheries, 90 m, 10°43'43"N, 76°40'35"E, 21 April 2021, *V. Suresh & Ambika GVCP-SV 631*; near Hanafi Sunnath Jamath Mosque, 88 m, 10°44'36"N, 76°40'24"E, 21 April 2021, *V. Suresh & Ambika GVCP-SV 632*.

Acknowledgements

We thank the Postgraduate and Research Department of Botany, Government Victoria College, Palakkad for providing facilities and support. We are also grateful to UGC-CSIR, Govt. of India for providing fellowship under the UGC-JRF scheme to the first author.

References

- Aiton, W. & Aiton, W.T. (1811) *Hortus kewensis, or: A catalogue of the plants cultivated in the Royal Botanic Garden at Kew*, vol. 2. London, 78 pp.
<https://doi.org/10.5962/bhl.title.105339>
- Angiosperm Phylogeny Group [= APG] IV (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181: 1–20.
<https://doi.org/10.1111/boj.12385>
- Baillon, H. (1864) *Adansonia; recueil periodique d'observations botaniques* 4: 339. [Paris]
- Byng, J.W. (2014) *The flowering plants handbook*. Plant Gateway, Hertford, U.K., 619 pp.
- Castillo-Campus, G. & Abreo, M.E.M. (2003) A new species of *Casearia* (Flacourtiaceae) from Mexico. *Novon* 13: 1. 30–33.
<https://doi.org/10.2307/3393561>
- Chase, M.W., Zmarzty, S., Lledo, M.D., Wurdack, K.J., Swensen, S.M. & Fay, M.F. (2002) When in doubt, put it in Flacourtiaceae: a molecular phylogenetic analysis based on plastid rbcL DNA sequences. *Kew Bulletin* 57: 141–181.
- Gentry, A.H. (1993) *A Field Guide to the Families and Genera of Woody Plants of Northwest South America (Colombia, Ecuador, Peru) with Supplementary Notes on Herbaceous Taxa*. Conservation International, Washington, DC, 895 pp.
- Hooker, W.J. (1852) *Hooker's journal of botany and Kew Garden miscellany* 4: 107. [London]
- IUCN (2022) Guidelines for using the IUCN Red List Categories and Criteria. Version 11. Prepared by the standards and petitions subcommittee. Available from: <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> (accessed 21 September 2022).
- Jacquin, N.J. (1760) *Enumeratio systematica plantarum, quas in insulis Caribaeis vicinaque Americae continente detexit novas, aut jam cognitae emendavit*. Theodorum Haak, Leiden, 21 pp.
<https://doi.org/10.5962/bhl.title.100687>
- Lamarck, J.B. (1804) *Encyclopedie methodique. Botanique*, vol. 5. Paris, 298 pp.
- Mabberley, D.J. (2017) *Mabberley's plant-book, 4th ed.* Cambridge University Press, Cambridge, 1102 pp.
<https://doi.org/10.1017/9781316335581>
- Marquete, R. & Mansano, V.F. (2016) O gênero *Casearia* Jacq. no Brasil. *Revista de Biologia Neotropical* 13 (1): 69–249.
<https://doi.org/10.5216/rbn.v13i1.26435>
- Nepomuceno, F.A.A & Alves, M. (2017) A new *Casearia* (Salicaceae) from the Atlantic Forest of Brazil. *Phytotaxa* 311 (3): 297–300.
<https://doi.org/10.11646/phytotaxa.311.3.12>
- Roxburgh, W. (1832) *Flora Indica*. vol. 2, Serampore, W. Thacker and Co. Calcutta, & Parbury, Allen and Co. London
- Samarakoon, T. (2015) *Phylogenetic relationships of Samydaceae and taxonomic revision of the species of Casearia in South-Central Asia*. Ph.D. Thesis. The University of Southern Mississippi, Hattiesburg, 160 pp.
- Sleumer, H. (1954) Flacourtiaceae. In: Van Steenis, C.G.G.J. (ed.) *Flora Malesiana*, ser. 1, vol. 5. Noordhoff-Kolff N.V, Djakarta, pp. 1–106.
- Sleumer, H. (1956) Note on the genus *Guidonia* Plumier. *Taxon* 5 (8): 192–194.
<https://doi.org/10.2307/1217623>
- Sleumer, H. (1971) Le genre *Casearia* Jacq. (Flacourtiaceae) en Afrique à Madagascar et aux Mascariègnes. *Bulletin du Jardin botanique national de Belgique/Bulletin van de Nationale Plantentuin van België* 41: 397–426.
<https://doi.org/10.2307/3667398>
- Sleumer, H. (1980) *Flora Neotropica, Monograph 22 Flacourtiaceae*. New York Botanical Garden, New York, 499 pp.

Sleumer, H. (1985) The Flacourtiaceae of Thailand. *Blumea* 30: 217–250.

Thiers, B. (2022 [continuously updated]) *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Available from: <http://sweetgum.nybg.org/ih/> (accessed 1 October 2022).

***OPHIGLOSSUM MADHUSOODANANII* (OPHIGLOSSACEAE) A STRIKING
NEW SPECIES FROM SOUTHERN WESTERN GHATS OF KERALA, INDIA**

SOJAN JOSE^{1*}, VENUGOPALAN NAIR SARADHAMMA ANILKUMAR^{2**}, SINDHU ARYA^{2***},
ALEN ALEX PHILIP^{3#}****, LEEJA LAKSHMANAN^{3*****} AND VEERANKUTTY SURESH^{3*****}

¹ Department of Botany, Govt. College, Chittur, Palakkad, Kerala-678104, India.

² Department of Botany, (Research Center, University of Kerala) University College,
Thiruvananthapuram, Kerala-695034, India.

³ Department of Botany, Government Victoria College, Palakkad, Kerala-678001, India.

(Received 1 April, 2022; Revised Accepted April 17, 2022)

ABSTRACT

A new species of *Ophioglossum* from the Western Ghats of Kerala (India) — *Ophioglossum madhusoodananii* — is described and illustrated. Morphological description as well as original photos and illustrations are given. *O. madhusoodananii* is similar to *O. costatum* from which it differs by the shape of rhizomorph and tropophyll, position of sporophore, sterile region at the tip of spike, number and arrangement of sporangium, nature of spore and its surface ornamentation.

Keywords : *Ophioglossum*, exine ornamentation, eusporangiate fern, sporophore, tropophore.

INTRODUCTION

The genus *Ophioglossum* (Linnaeus 1753); Ophioglossaceae Martinov comprises nearly 52 species worldwide (Yadav & Goswami 2010, Patil & Dongare 2014) of which 24 species are reported from India (Fraser-Jenkins *et al.* 2017, Patel & Reddy 2018, Patel *et al.* 2018, Patel & Reddy 2019, Patil *et al.* 2020). Most of the species generally grow in humus rich moist soil; however they are also represented by epiphytic forms (eg; *O. pendulum*). *Ophioglossum* has 8 species reported from southern Western Ghats (Patil & Dongare 2014) and 6 from Kerala (Madhusoodanan 2015). Continuous explorations at various regions are introducing new taxa for the genus through palynological and phylogenetic approaches (Patel & Reddy 2018, Patel *et al.* 2018).

During floristic exploration along the wetlands of the Palakkad gap region of the Western Ghats in Kerala, the authors have collected an interesting specimen belonging to genus *Ophioglossum*. Critical analysis of the population, for a period of five years based on all the available literatures and herbarium specimens revealed a combination of characters that supports its circumscription as a new species.

MATERIAL AND METHODS

The specimen of *Ophioglossum* was collected as part of the extensive field surveys carried out in various geographical locations of the Palakkad gap region in the state of Kerala during 2017 – 2022. The systematic analysis of the collected specimens were carried

E-mail : * sojanchakkalackal@gmail.com ** aryasindu001@gmail.com *** vsanilbotany@gmail.com
**** alenloveplants@gmail.com ***** drleejapramod@gmail.com ***** sureshmagnolia@gmail.com
Author for correspondence

out using relevant literature (Clausen 1938, Panigrahi & Dixit 1969, Manickam & Irudayaraj 1991, Patil & Dongare 2014, Madhusoodanan 2015, Fraser-Jenkins *et al.* 2017, Patel *et al.* 2018) and examination of specimens preserved at K, JCB and CALI (acronyms according to Thiers (2022+)). A total of 30–40 individuals have been analyzed for consistent traits and recorded. Considering the view that the spore micromorphology is essential to delineate the species coming under the genus *Ophioglossum*, Scanning Electron Microscopy of spores was carried out and both distal and proximal surfaces were analyzed (carl Zeiss Evo 18).

TAXONOMIC TREATMENT

Ophioglossum madhusoodananii Sojan, V.S.A. Kumar, Sindhu Arya, V. Suresh, L. Leeja & Alen Alex *sp. nov.* (Fig 1, 2 & 3).

Type : INDIA. Kerala, Palakkad District, Vengappara 10°34'29.20"N, 76°42'50.77"E 27 June 2019 Suresh V GVCPSV 823 (holotype UCBD!; isotypes UCBD!).

Diagnosis : *Ophioglossum madhusoodananii* is morphologically similar to *O. costatum* R. Br. (Brown 1810: 163), but differs mainly in the shape of rhizomorph (subglobose to discoid in *O. madhusoodananii* vs. globose in *O. costatum*), arrangement of sporangium (opposite in *O. madhusoodananii* vs. alternate in *O. costatum*), strobilus (often branched at apex in *O. madhusoodananii* vs. unbranched in *O. costatum*), number of sporangium (in about 35–60 pairs in *O. madhusoodananii*, vs. 20–35 pairs in *O. costatum*), apex of trophophyll (acute in *O. madhusoodananii* vs. obtuse-mucronate in *O. costatum*), fusion of sporophore (at the base of trophophore in *O. madhusoodananii* vs. from the middle of trophophore in *O. costatum*) and the nature of spike (with sterile tip of 1–2 mm in *O. madhusoodananii* vs. completely fertile in *O. costatum*). Further, differences in spore morphology *viz* size, (35–40 µm in *O. madhusoodananii* vs. 25–35 µm in *O. costatum*), exine (Distal View: widely spaced pits with pentagonal to circular margin, tubercles present in pits, apparently foveolate in *O. madhusoodananii* vs. narrowly spaced pits with smooth surface and tubercles absent, margin hexagonal in *O. costatum*; Proximal view: laesurae unequal narrow, pits deep, margin surrounded by radially extended cells in *O. madhusoodananii* vs. laesurae equal, wide, not depressed, surface and margin with cells of shallow lumen in *O. costatum*) demarcates the new taxon.

Description (Macromorphology) : Plants terrestrial, 15–22 cm height, perennial herbs. Underground rhizomorph tuberous, subglobose to discoid with trophophore arising from a suppression at the center, 8–12 mm diameter, fleshy, scaly, scales brown, rusty. Aerial parts with 1–5 trophophores from one tuber, erect, up to 22 cm high, having 2 parts, trophophyll and sporophyll. Trophophore arising from tuber and gradually attenuate into a common stalk with sporophore, demarcation between trophophores and stalks hard to demarcate at base, 4–5 cm long; basal region terete, 1.5–2.5 mm in diameter, white; trophophyll flat, 6–11 cm long, 1.5–2 cm broad, dark green; acute at apex. Sporophores

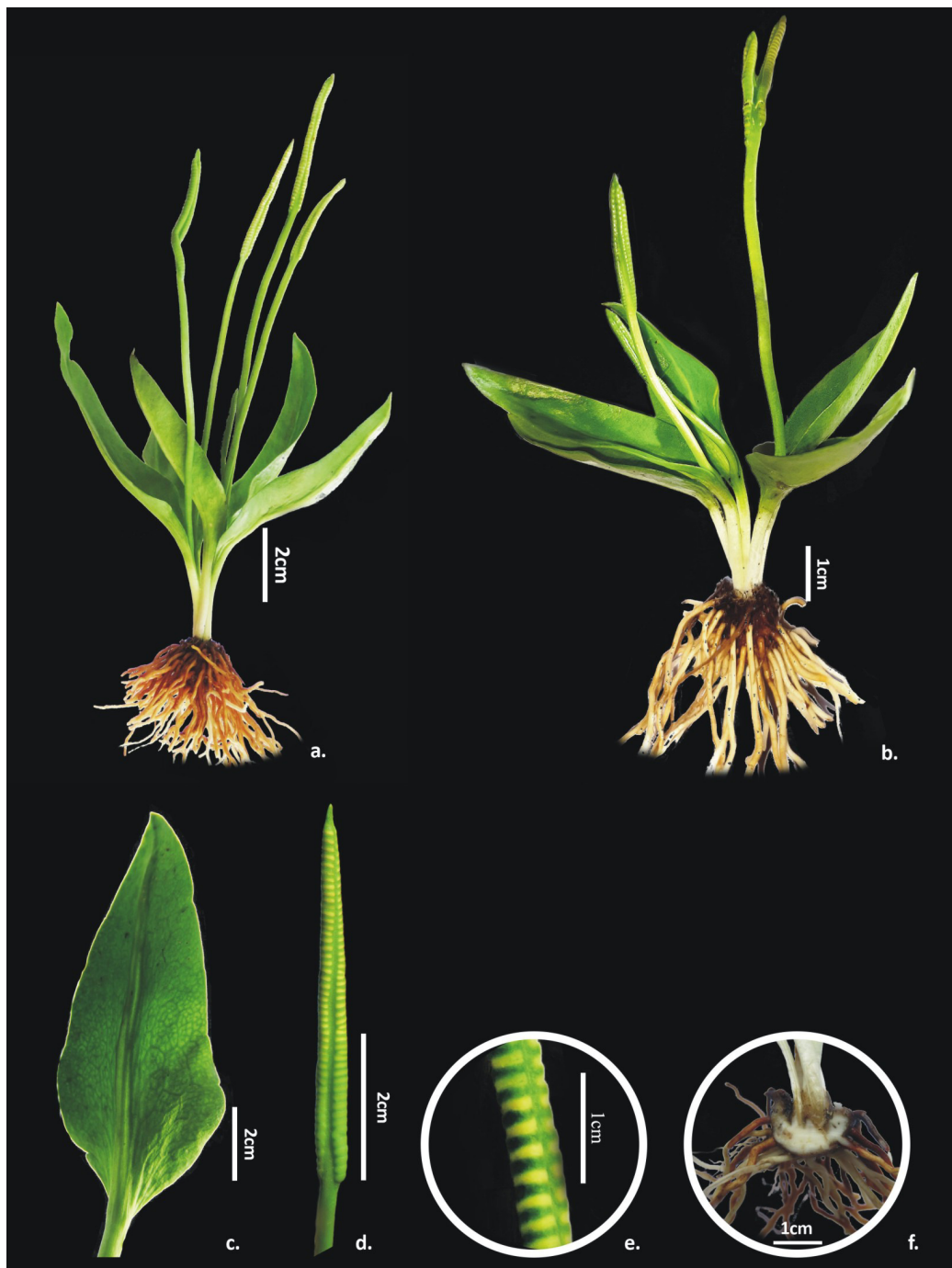


Figure 1. a. and b. *Ophioglossum madhusoodananii* Sojan, V.S.A. Kumar, S. Arya, V. Suresh, L. Leeja & Alen Alex *sp. nov.* a. and b. Habit showing both unbranched and branched spike; c. Trophophyll; d. and e. Spike; f. L. S. of rhizomorph.

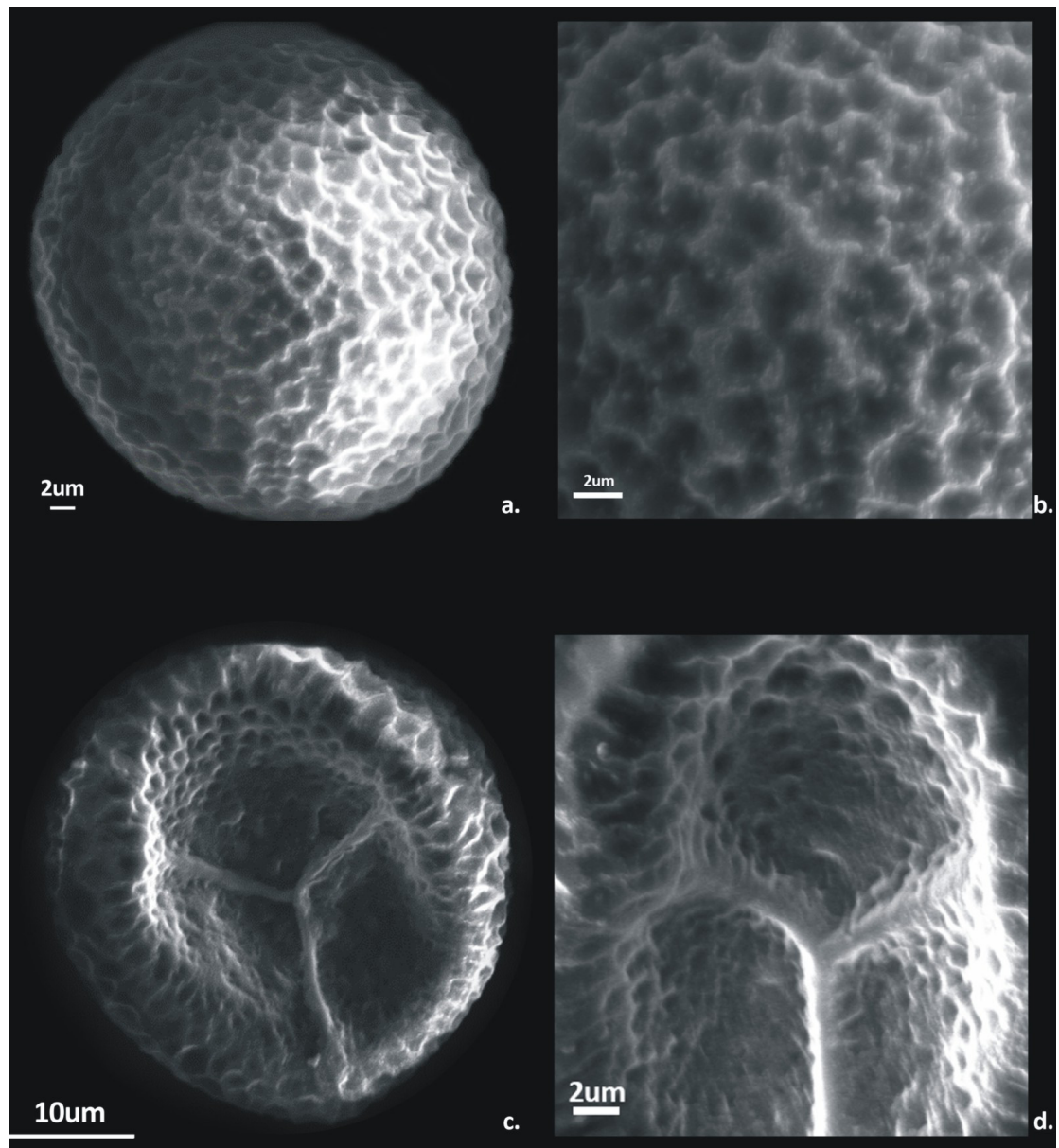


Figure 2. *Ophioglossum madhusoodananii* Sojan, V.S.A. Kumar, S. Arya, V. Suresh, L. Leeja & Alen Alex *sp. nov.* **a.** Distal side of spore; **b.** Close up of distal side of spore; **c.** Proximal side of Spore; **d.** Close up of proximal side of spore.

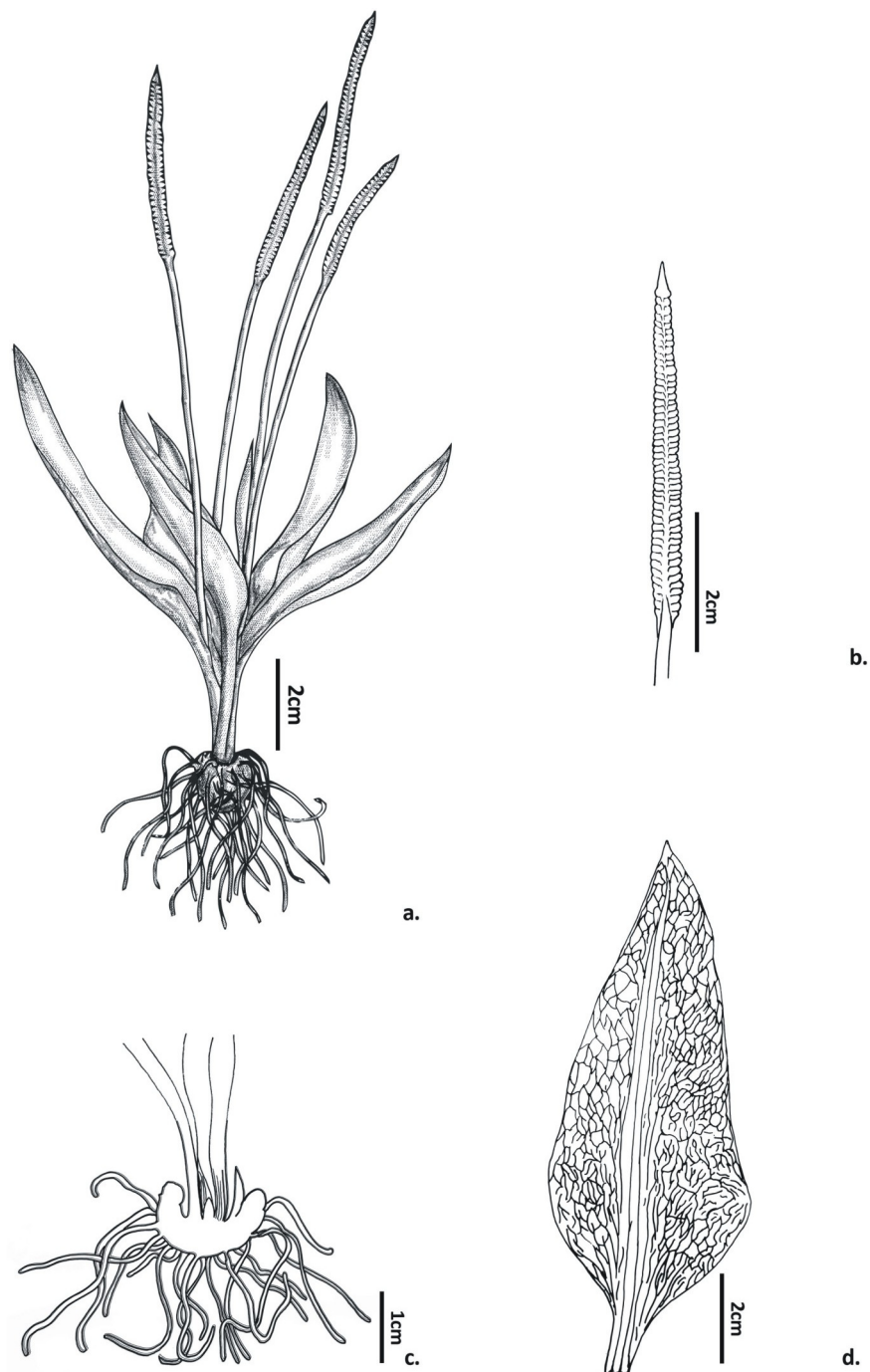


Figure 3. *Ophioglossum madhusoodananii* Sojan, V.S.A. Kumar, S. Arya, V. Suresh, L. Leeja & Alen Alex *sp. nov.* illustration: **a.** Habit; **b.** Spike; **c.** L.S. of rhizomorph; **d.** Trophophyll

9–14 cm long, arising at the base of trophophores, consisting of a long stalk and a fertile spike; stalks 6–11 cm long, ca. 2 mm in diameter, semicircular; fertile spikes 2–5 cm long bearing 35–60 pairs of sporangia, often branched, sterile tip of 1–2 mm. Spores whitish, globose, equatorial diameter up to 40 mm.

Description (micromorphology) : The spore measures 40 mm in diameter, globose and trilete, circular type, with a slightly winged rim visible around it in top view. The distal surface of the spore has unique sculpturing with pits surrounded by pentagonal to circular margin in a regular spirocyclic style. The surface of pits are rough scattered with tubercles having blunt to round apex, often protruding. The proximal face of the spore has a narrow triradiate mark, pits deep with cells of large conspicuous lumen, tubercles absent, laesurae 9.9–11.9 mm, unequal, narrow, almost reaching the margin surrounded by radially extended large cells.

Etymology : The species is named in honor of Prof. Pandara Valappil Madhusoodanan, Former Head, Department of Botany, University of Calicut in recognition of his remarkable contributions to the field of pteridology in India.

Fertile phase : June-September

Distribution and ecology : The species occur in the seasonal wetlands associated with the granite hillocks of Vengappara in Chittur taluk of Palakkad district. The associated species include *Calamaria coromandelina* (Kuntze, 1891: 828), *Cyperus iria* (Linnaeus, 1753: 45), *Hygrophila auriculata* (Hein, 1962: 172) etc.

Conservation status : The new species is known only from the type locality. Further explorations in similar habitats throughout Palakkad gap region of Western Ghats, covering the states of Kerala and Tamil Nadu are required to establish the conservation status. The threat posed by continuous granite mining activities in this region call for conservation of the particular habitat and the novel species. Depending on the available data, the species can be categorized under Data deficient category (DD).

Taxonomic notes : The genus *Ophioglossum* has wide distribution across tropical and subtropical regions of the world (Patil & Dongare 2014). Various *Ophioglossum* species reported from southern Western Ghats include *Ophioglossum costatum* (Brown 1810: 163), *O. gramineum* (Willdenow 1802: 18), *O. petiolatum* (Presl 1845: 327), *O. lusitanicum* (Linnaeus 1753: 1063), *O. parvifolium* (Grev. & Hooker 1833: 218) *O. petiolatum* (Hooker 1823: 56), *O. polyphyllum* (A. Braun ex Seub. 1844:17) and *O. reticulatum* (Linnaeus 1753: 1063). *O. madhusoodanani* differs from other species of *Ophioglossum* so far reported from southern Western Ghats of India. The new species discussed in the present investigation closely resembles *O. costatum* and its differences are summarized in Table 1. The new species also shows similarity with *O. nudicaule*, with respect to subglobose shape of rhizomorph bearing many soft fibrous roots but differs with respect to the acute apex of the trophophyll (obtuse in *O. nudicaule*), presence of dark brown scales in the rhizome, (absent in *O. nudicaule*) number of sporangia (up to 20 pairs in *O. nudicaule* vs. 35–60

TABLE 1 : Morphological comparison between *O. madhusoodananii* and *O. costatum*.

Characters	<i>O. madhusoodananii</i>	<i>O. costatum</i>
Rhizomorph	Subglobose to discoid	Globose
Strobilus	Often branched	Unbranched
Arrangement of sporangium	Opposite, mature spike shows a spiral alignment from the middle region.	Alternate, straight alignment of spike throughout length.
Number of sporangium	35–60 pairs	20–35 pairs
Trophophyll	Lanceolate with acute apex	Lanceolate to ovate with obtuse-mucronate apex
Fusion of sporophore	From the base of the trophophore	From the mid-region of the trophophore
Spore	35–40 µm, Distal view: exine with widely spaced pits, tubercles present in pits, margin pentagonal to circular (apparently foveolate) Proximal view: laesurae unequal narrow, pit deep, margin surrounded by radially extended cells	25–30µm, Distal view: exine with narrowly spaced pits, tubercles absent, margin hexagonal Proximal view : laesurae equal, wide, not depressed, surface and margin with cells of shallow lumen
Tip of spike	Sterile, sterile region 1–2 mm in length	Fertile, Sterile region absent
Venation	Veins diverging from the base and anastomosing through the trophophyll and veins forming network of aureoles and closed veinlets in marginal parts	Veins forming large areoles and free ending veinlets in marginal parts

pairs in *O. madhusoodananii*) and arrangement of sporangia (alternate in *O. nudicaule* vs. opposite in *O. madhusoodananii*) and circular shape of the spore. Further it can be noted that the shape of rhizomorph also shows certain degree of resemblance with *O. reticulatum* but differs with respect to lanceolate-ovate shaped trophophyll, basal fusion of sporophore with respect to trophophore and spore architecture.

Additional specimens examined :

INDIA. Kerala, Palakkad district, Vengappara 10°34'27.56"N, 76°42'48.63"E, 29 June 2019, Suresh V & Sojan GVCP-SV 1825; Vengappara 10°34'29.52"N, 76°42'52.34"E,

28 June 2020, Suresh V GVCP-SV 1828; Edachira 10°35'13.73"N, 76°43'30.72"E, 03 July 2020 Sojan and Suresh V GVCP-SV 1829.

ACKNOWLEDGEMENTS

The authors acknowledge the curators of the National herbaria in which the specimens have been deposited. All authors acknowledge the principal of respective centers and Director of Collegiate Education, Kerala.

REFERENCES

- BROWN, R. 1810. Prodrum florae Novae Hollandiae Johnson & Soc. London: 1196.
- CLAUSEN, R.T. 1938. A monograph of the Ophioglossaceae. Memoirs of the Torrey Botanical Club **19(2)**: 1–177.
- FRASER-JENKINS, C.R., GANDHI, K.N., KHOLIA, B. & BENNIAMIN, A. 2017. An annotated checklist of Indian Pteridophytes Bishen Singh Mahendra Pal Singh Dehra Dun 1–562.
- HEINE, H. 1962. Tropical African Plants: XXVI. Some West African Acanthaceae Kew Bulletin **16**: 161–183.
- HOOKE, W.J. 1823. Exotic Flora. Blackwood: 56.
- HOOKE, W.J. & GREVILLE, R.K. 1833. Additions and corrections to the Enumeratio Filicum Botanical Miscellany, Hooker **3**: 104–109.
- KUNTZE, O. 1891. Revisio generum plantarum, Leipzig: Arthur Felix **2**: 828.
- LINNAEUS, C. 1753. Species Plantarum Impensis Laurentii Salvii: 1200.
- MADHUSOODANAN, P.V. 2015. Hand Book on Ferns and Fern Allies of Kerala. Malabar Botanical Garden and Institute for Plant Sciences.
- MANICKAM, V.S. & IRUDAYARAJ, V. 1991. Pteridophyte Flora of the Western Ghats, South India. B.I. Publications.
- PANIGRAHI, G. & DIXIT, R.D. 1969. The family Ophioglossaceae in India. Studies in Indian Pteridophytes-IV. *Proceedings of the National Academy of Sciences, India*, **35B**: 230–266.
- PATEL, M. & REDDY, M. N. 2018. Discovery of the World's smallest terrestrial pteridophyte. *Scientific reports* **8**: 5911.
- PATEL, M. & REDDY, M.N. 2019. Revealing a new species of *Ophioglossum* (Ophioglossaceae-Pteridophyta) from India with palynological and phylogenetic implications. *Botany Letters* **166**: 425–433.
- PATEL, M., REDDY, M.N. & GOSWAMI, H.K. 2018. A Terrestrial Large-sized *Ophioglossum aletum*: New Species from Gujarat, India. *Indian Fern Journal* **35**: 318–331.
- PATIL, S. & DONGARE, M. 2014. The genus *Ophioglossum* from Western Ghats of India. *Indian Fern Journal* **31**: 17–24.
- PATIL, S.M., PATEL, S.K., RAOLE, V.M. & RAJPUT, K.S. 2020. *Ophioglossum jaykrishnae* (Ophioglossaceae) : A species novo from Gujarat State. *Indian Fern Journal* **37** : 239-245.
- PRESL, K.B. 1845. Supplementum tentaminis pteridographiae Haase: 327.
- SEUBERT, M., HOCHSTETTER, C.F. & HOCHSTETTER, K.C.F. 1844. Flora Azorica : quam ex collectionibus schedisque Hochstetteri patris et filii. Apud A. Marcum, Bonnae: **17**.
- THIERS, B. 2022. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium.
- WILLDENOW, C.V. 1802. Nova Academia Erfurt: **18**.
- YADAV, B.L. & GOSWAMI, H.K. 2010. A new, pink-brown *Ophioglossum* (Ophioglossaceae) from India. *Bulletin of the National Museum of Nature and Science Series B* **36**: 155–159.

Three new species of *Polycarpaea* (Caryophyllaceae) from Kerala, South India

Sindhu Arya¹, Venugopalan Nair Saradamma Anil Kumar¹,
Ambika Viswanathan Pillai², Alex Philip Alen², Jose Sojan³, Veerankutty Suresh²

1 Department of Botany, University College, University of Kerala, Thiruvananthapuram, Kerala– 695 034, India **2** Department of Botany, Government Victoria College, University of Calicut, Palakkad, Kerala– 678001, India **3** Department of Botany, Government College, Chittur, Palakkad, Kerala– 678104, India

Corresponding author: Venugopalan Nair Saradamma Anil Kumar (vsanilbotany@gmail.com)

Academic editor: G. P. Giusso del Galdo | Received 3 July 2022 | Accepted 12 September 2022 | Published 14 November 2022

Citation: Arya S, Kumar VN SA, Pillai AV, Alen AP, Sojan J, Suresh V (2022) Three new species of *Polycarpaea* (Caryophyllaceae) from Kerala, South India. *PhytoKeys* 213: 95–110. <https://doi.org/10.3897/phytokeys.213.89875>

Abstract

Three new species of *Polycarpaea*, *Polycarpaea barbellata*, *P. ebracteata* and *P. psammophila*, are described from the Palakkad district of Kerala, India. The new species are allied to *P. corymbosa* and *P. aurea* but can be visibly distinguished by unique character combinations, *viz.* shape of sepal, petal, bract and bracteole and seed morphology. Detailed descriptions along with illustrations and photographs are provided.

Keywords

Caryophyllales, Palakkad gap, *Polycarpaea*, Western Ghats

Introduction

The genus *Polycarpaea* Lamarck (1792: 3) (Caryophyllaceae Juss.) comprises approximately 50 species which are mostly distributed in the tropics and subtropics of the old world and a few occur in the New World tropics (Dequan and Gilbert 2001; Mabberley 2008). The genus is represented in India by seven species (Arya et al. 2021).

During the field exploration carried out as part of the floristic studies of the southern Western Ghats in the Kerala region, several specimens of morphologically unique *Polycarpaea* were collected from the hillocks of Palakkad district (Northern

Kerala, India). On the basis of critical evaluation of collected specimens, comparison with various herbaria and through literature review, we found that these specimens are distinct from all other known species. Hence, we propose them as novel species.

Materials and methods

Forest exploration trips were carried out during the period of June–January of 2020–21. Herbarium specimens of collected plants were deposited in the Herbarium UCBD. Additional herbarium specimens were examined from the Herbaria E, MH, K, TBGT, UCBD (acronyms according to Thiers 2022 [continuously updated]). Relevant literatures were analyzed (Wight 1843, 1850; Edgeworth and Hooker 1874; Dunn 1915; Majumdar 1993; Daniel et al. 2000; Venu et al. 2001; Daniel 2005; Mastakar et al. 2015; Geethakumary et al. 2019). A total of more than 50 flowers from each species were assessed to confirm the consistency of traits in the collected specimens and to validate the character occurrence.

Results and discussion

Polycarpaea ebracteata S. Arya, V.S.A. Kumar, V. Suresh & Alen Alex, sp. nov.

urn:lsid:ipni.org:names:77307989-1

Figs 1, 2

Type. INDIA. Kerala, Palakkad district, Kollengode forest range, Nenmeni, Vengappara 10°34'33.6"N, 76°42'47.1"E, 160 m a.s.l., 20 September 2021, Suresh V., V.S.A. Kumar & Arya S., 2077 (holotype UCBD! isotype UCBD!).

Diagnosis. *Polycarpaea ebracteata* is morphologically similar to *Polycarpaea corymbosa* in terms of having prominent villous stem nodes and shape of petals but differs with respect to stipules (short, ovate less than 1mm, *vs.* lanceolate, long, 5 mm) bracts (absent *vs.* present), bracteoles (absent *vs.* present), sepals (ovate, acute at apex, not membranous *vs.* lanceolate, acuminate apex, hyaline, membranous), petals (dark brown, ovate-elliptical *vs.* whitish-pink, broadly ovate), stamens (filament reduced, 0.1 mm *vs.* filaments equal to the length of anther 1 mm), capsule (style not persistent, tips curved *vs.* style persistent, tips not curved) and seeds (3–4 or rarely 2, yellow, ovate *vs.* 5–13, brown, reniform).

Description. Annual herbs, erect or sub-erect, branched at base, 2.5–8 cm high. Stem terete, densely villous, nodes green, swollen, internodes ca. 5 mm long. Leaves whorled or verticillate, sessile, linear, green, 0.7–0.9 cm long, base cordate, margins smooth, apex acute or acuminate, surface glabrous, blade 1-veined, prominent on abaxial side; stipules scarious, ovate-obovate, (0.2–0.8 × ca. 0.6 mm), margins entire, acute, not nerved, yellowish or greenish at the base, white above. Inflorescence terminal, branched cyme, ca. 1.0 cm long; Flowers 2.2–2.6 mm long; Bracts absent. bracteoles absent; pedicels 1.0–1.3 mm long, green, villous. Sepals 5, free, ovate (1.3–1.4 × ca. 0.7 mm), entire at the margin, acute or obtuse at apex, white, non-membranous

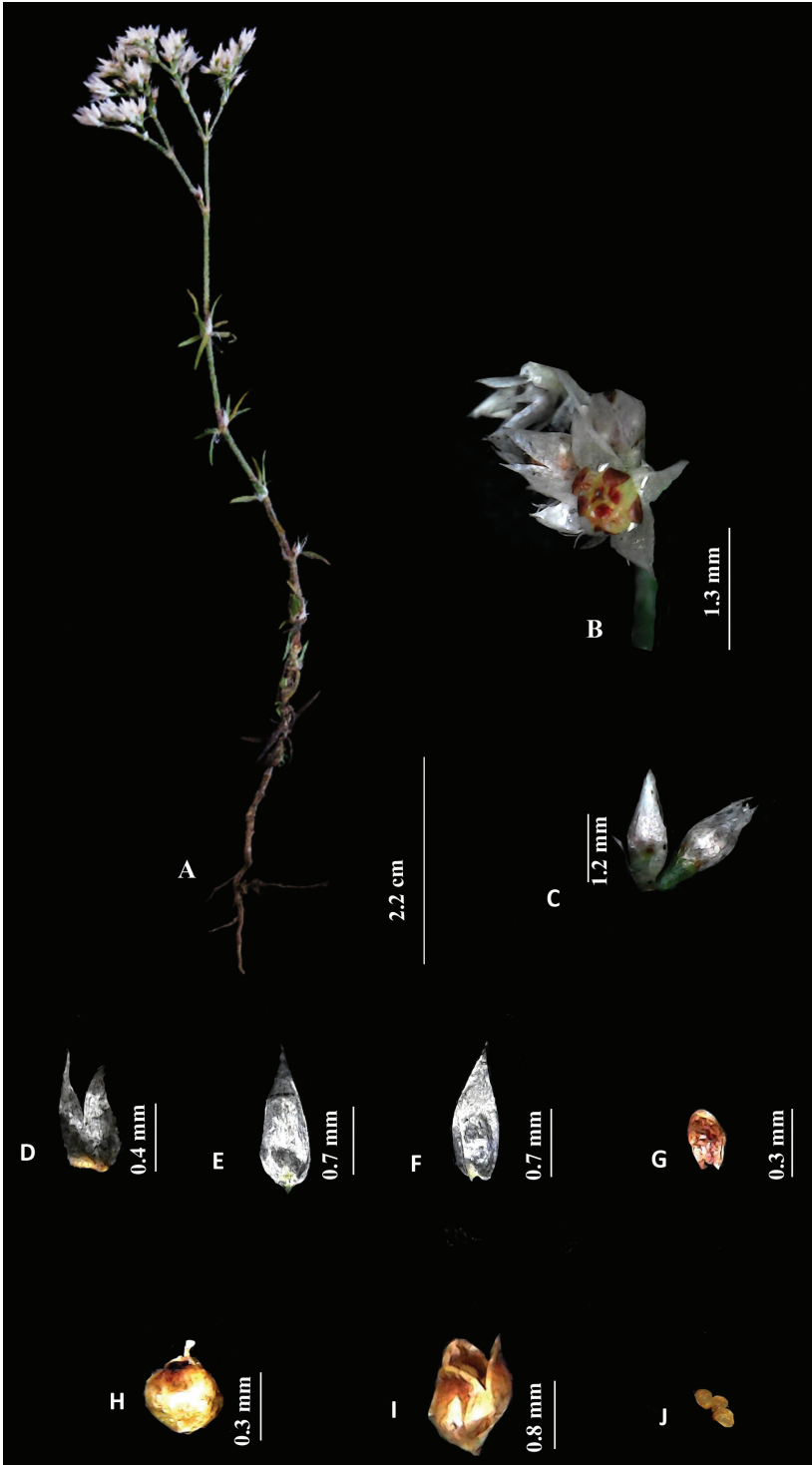


Figure 1. *Polycarpaea ebracteata* **A** habit **B** flower **C** flower bud **D** stipule **E, F** sepal **G** petal **H** gynoe-cium **I** capsule **J** seed. Photos by Arya Sindhu.

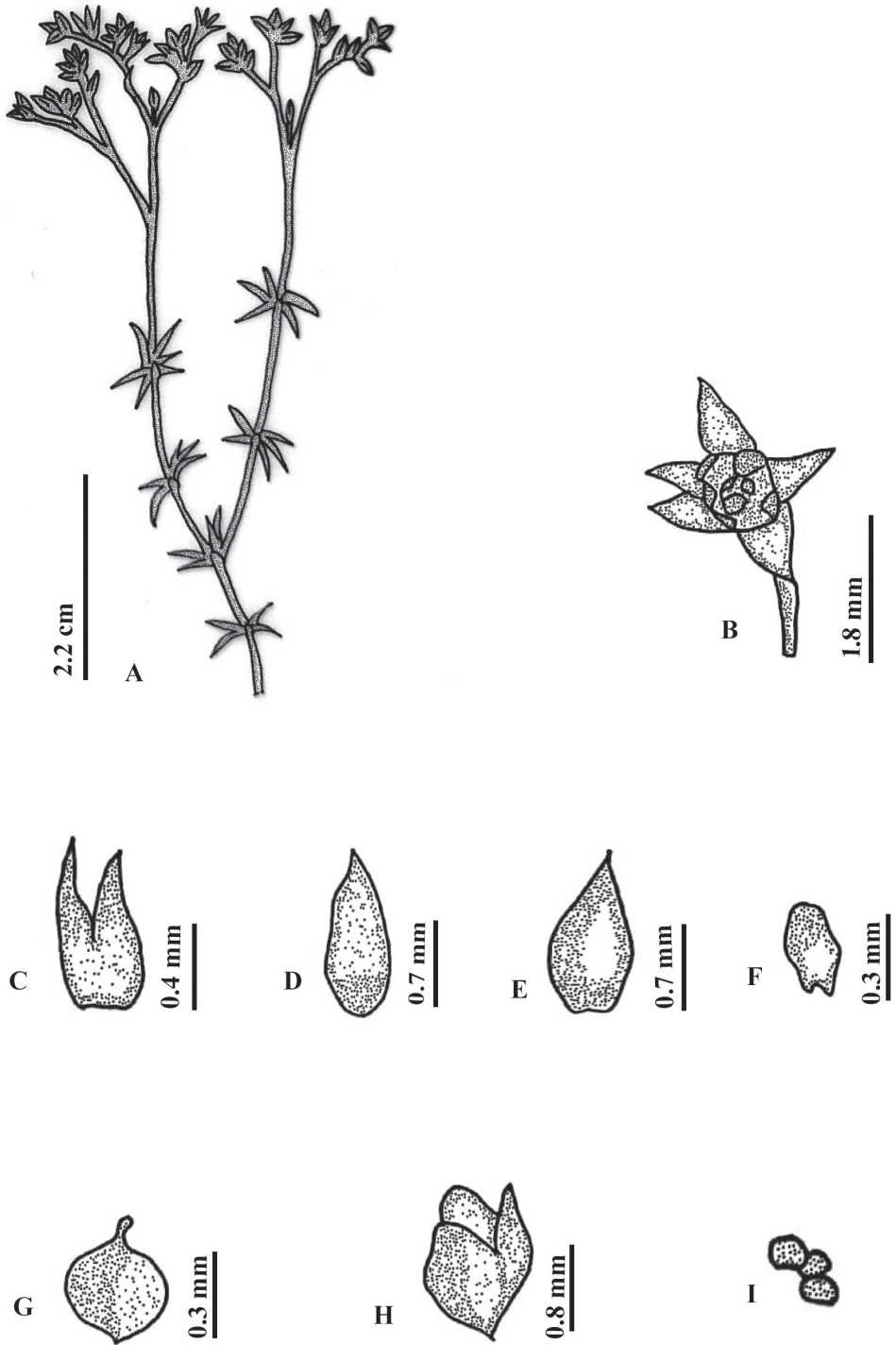


Figure 2. *Polycarpha ebracteata* **A** habit **B** flower **C** stipule **D, E** sepal **F** petal **G** gynoeceium **H** capsule **I** seed. Illustration by Ambika Viswanathanpillai.

base round, midrib not prominent. Petals 5, ovate (0.1–0.3 × 0.1–0.3 mm), margins entire, oblong to round at apex, partially enclosing the ovary, 1/4 as short as sepals, dark red-brown. Stamens 5, forming a ring with petals and encircling the ovary, ca. 0.2 mm long; anthers yellow, oblong, basifixed. Ovary 1-loculed, shortly stipitate, spheroidal, 0.3–0.5 × 0.1–0.2 mm, glabrous, placentation free central; style 0.08–0.1 mm, shorter than the ovary, slender; stigma capitate. Capsule ovoid (1.4–1.6 × ca. 0.6 mm), shortly stipitate, 3-valved, breaks along the suture, brownish, scarious along margin. Seeds 3–4 (rarely 2), ovate (0.2–0.3 × 0.1–0.2 mm), yellow with no striations.

Micromorphology of the seed shows that it is round-oblong with a winged margin. The surface has sub parallel striations which are prominent. The striations do not cross each other and the encircling surface of the striations are punctate. Along the margins, the surface has parallel striations (Fig. 7E, F).

Etymology. Latin prefix e-, without, bractea, bract, and suffix -ata, possession, alluding to absence of bracts, a diagnostic character.

Phenology. Flowering and fruiting during August – December

Distribution and habitat. The primary habitat of *Polycarpaea ebracteata* is the hillock terrains in Palakkad district (Granite outcrop in the southern side of Palakkad gap, the largest break in the Western Ghats having an arid climate with seasonal fires, in the state of Kerala). One of the common species that emerges after the initial rain are members of the Genus *Polycarpaea*, especially *Polycarpaea aurea* (Wight 1850: 44) Dunn (1915: 65). *Polycarpaea ebracteata* is seen associated with *Allmania nodiflora* (L.) R. Br. ex Wight, *Indigofera aspalathoides* DC. and *Fimbristylis cymosa* R. Br. (Fig. 8).

Conservation status. The present study could report only three populations each with 15–20 individuals. Since *Polycarpaea ebracteata* could occur in further sites in SW-India (and India as a whole), we think that further data is required to ascertain the conservation status of the new taxon. As a consequence, the new species is here assessed as DD (Data Deficient) according to the IUCN criteria (IUCN 2021).

Additional specimens examined. *Polycarpaea ebracteata* INDIA. Kerala, Palakkad district, Kollengode, Cheerani. 12 September 2021, Suresh V. & Alen Alex Philip, 2061 (UCBD!); 20 September 2021, Sojan Jose & Suresh V, 2078 (UCBD!).

***Polycarpaea psammophila* V. Suresh, V.S.A. Kumar, S. Arya, & Alen Alex, sp. nov.**

urn:lsid:ipni.org:names:77307990-1

Figs 3, 4

Type. INDIA. Kerala, Palakkad district, Nenmara, Ayinampadam, 10°35'29.4"N, 76°34'48.2"E, 140 m a.s.l., 21 September 2021, Suresh V. & Arya S., 2081 (holotype UCBD! isotype UCBD!).

Diagnosis. *Polycarpaea psammophila* is morphologically similar to *Polycarpaea corymbosa* with respect to the whorled arrangement of leaves and pilose nature of stem but differs with respect to stipules (linear to lanceolate with acuminate apex *vs.* lanceolate-ovate, with acute apex), bract (lanceolate-oblancheolate white, exceeding the length of

sepal *vs.* lanceolate-ovate, shorter than the sepal), bracteoles (linear with acicular apex *vs.* lanceolate with acute apex), petals (ovate – oblate, keeled, dark brown, apex pointed upwards *vs.* broadly ovate, not keeled, whitish-pink, round at apex), gynoecium (oblate spheroidal, reddish yellow *vs.* ovate short, green), capsule (four valved *vs.* three valved) and seeds (20–25 yellowish brown, ovate *vs.* 5–13, brown, reniform).

Description. Annual herbs, erect or sub-erect, 18–25 cm high. Stems terete, densely villous, nodes green, swollen, internodes ca. 1.5–2 cm long. Leaves whorled, sessile, linear-lanceolate, green, 2.3–3.1 cm long, base round, margin smooth, daggered in young leaf, apex acute or obtuse abaxial surface glabrous, adaxial surface pubescent along the mid vein; blade 1–2 veined, prominent on abaxial side; stipules prominent, linear to lanceolate, fused at the base (5–8 × ca. 2 mm), base golden yellow with unicellular setae; setae hyaline; margins entire, often bifurcated into two, branches acicular at apex, not nerved, milky white. Inflorescence terminal, irregular, branched lax cyme, ca. 10 cm long; Bracts lanceolate-oblong, exceeding the length of the sepal (2.0 – 2.3 × ca. 0.3 mm); base smooth, margin entire, apex acuminate. Bracteole 1.3 mm linear with acicular apex, holding the bracts in position. Flowers 8–10 per cyme, 4–5.5 mm long; pedicels 1.0–1.3 mm long, green villous. Sepals 5, free, obovate-oblong (2.3–2.6 × ca. 0.7 mm), entire at the margin, acute or obtuse at apex, white, non-membranous base round, midrib faint. Petals 5, ovate-oblong (1–1.3 × 1.1–1.3 mm), margin entire, keeled, pointed upward at apex, partially or completely enclosing the ovary, 1/2 as short as sepals, dark red-brown. Stamens 5, forming a ring with petals and encircling the ovary, ca. 0.3 mm long; anthers yellow, oblong, basifixed. Ovary 1-loculed, shortly stipitate, spheroidal, reddish-yellow 1.2–1.3 × 1–2 mm, glabrous, placentation free central; style 0.2–0.3 mm, shorter than the ovary, often very reduced and slender; stigma capitate. Capsule oblate-prolate (1.4–1.6 × ca. 0.6 mm), style persistent, shortly stipitate, 4-valved, breaks along the suture, brownish, scarious along margin. Seeds (20–25) ovate (0.2–0.3 × 0.1–0.2 mm), yellowish brown with striations.

Micromorphology of the seed exhibits a sub-orbicular shape with striations that are not parallel and cross each other towards the margin. The epidermal cell pattern is angular to spheroidal. Seed margin is entire and along the margin the cells are rectangular shaped (Fig. 7G, H).

Phenology. Flowering and fruiting during August– December.

Etymology. Greek psamos, sand, and philios, loving, alluding to exclusive habitat of sandy marginal zones of granite hills.

Habitat and distribution: The primary habitat of *Polycarpea psammophila* is the hillock terrains in Palakkad district along the sandy margins. It is seen associated with *Tephrosia purpurea* (L.) Pers., *Parasopubia delphiniifolia* (L.) H.-P. Hofm. & Eb. Fisch. and *Glinus oppositifolius* (L.) A. DC. (Fig. 8).

Conservation status. The current study is based on two different populations ranging from 50–80 individuals. We believe that further data is needed to determine the conservation status of *Polycarpea psammophila* because it could be found in other locations in SW-India (or India as a whole). As a result, according to IUCN criteria, the new species is classified as DD (Data Deficient) (IUCN 2021).

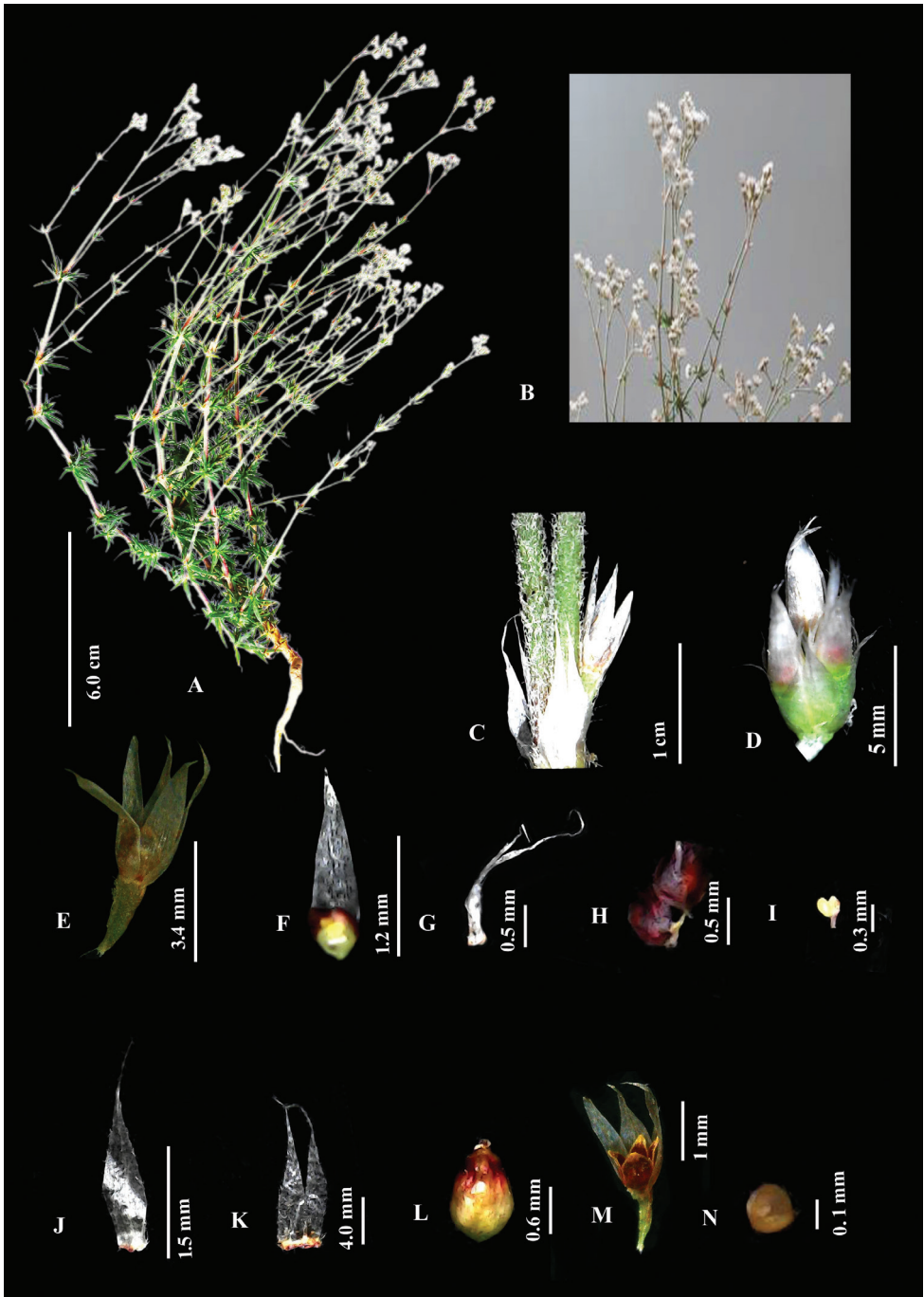


Figure 3. *Polycarpaea psammophila* **A** habit **B** inflorescence **C** internode **D** flower cluster **E** flower **F** bract **G** bracteole **H** petal **I** stamen **J** sepal **K** stipule **L** gynoecium **M** capsule **N** seed. Photos by Suresh V.

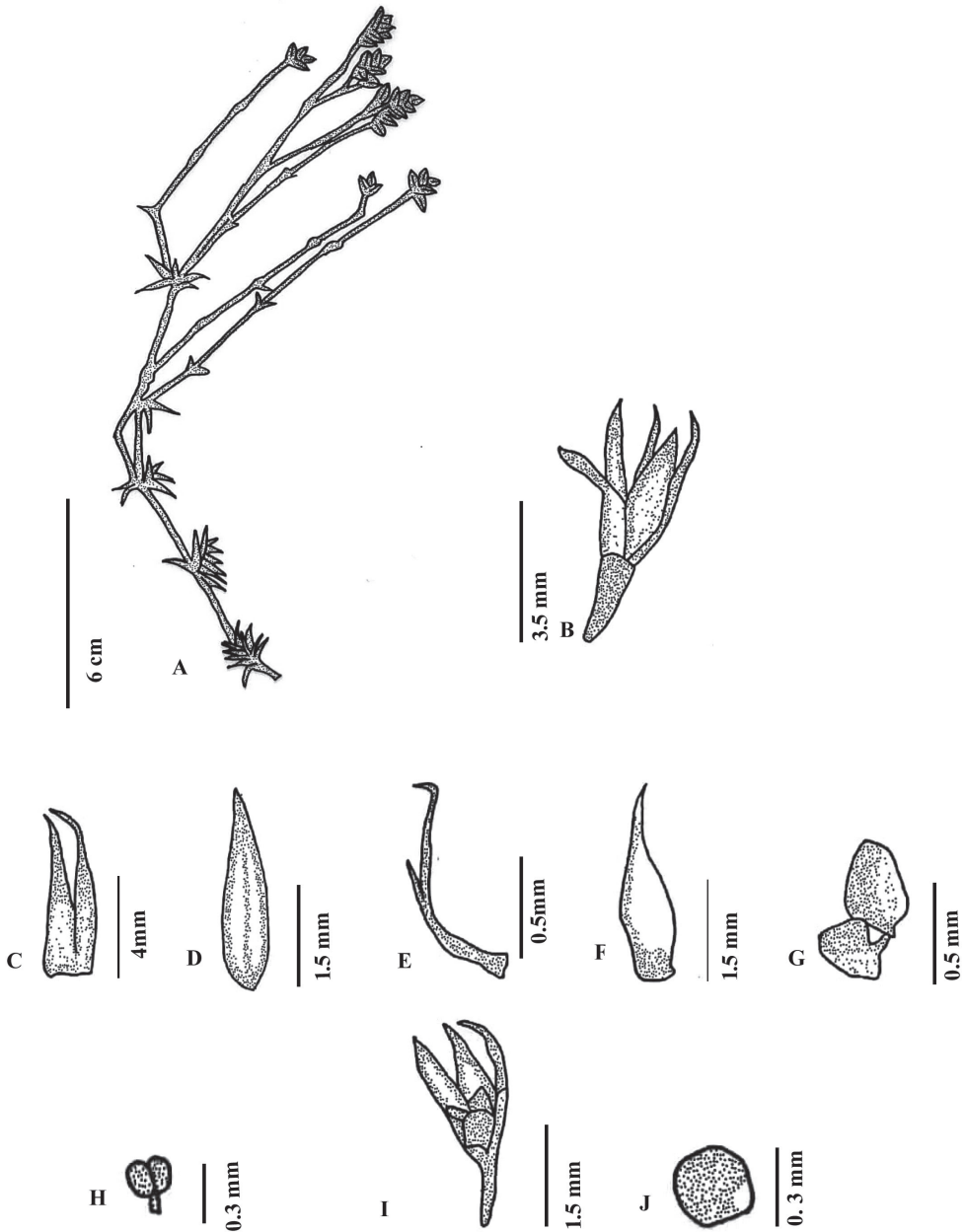


Figure 4. *Polycarpaea psammophila* **A** habit **B** flower **C** stipule **D** bract **E** bracteole **F** sepal **G** petal **H** stamen **I** capsule **J** seed. Illustration by Ambika Viswanathanpillai.

Additional specimens examined. INDIA. Kerala, Palakkad district, Nenmara, Vallangi, 12 September 2021, Suresh V. & Alen Alex Philip, 2065 (UCBD!); 21 September 2021, Sojan Jose & Kumar V.S.A., 2083 (UCBD!).

***Polycarpaea barbellata* V.S.A. Kumar, S. Arya, V. Suresh & Alen Alex, sp. nov.**

urn:lsid:ipni.org:names:77307991-1

Figs 5, 6

Type. INDIA. Kerala, Palakkad district, Kuthanur, Chedukamala 10°41'42.6"N, 76°31'06.3"E, 150 m a.s.l., 20 October 2021, V.S.A Kumar, Suresh V & Arya S., 3010 (holotype UCBD! isotype UCBD!).

Diagnosis. *Polycarpaea barbellata* is morphologically similar to *Polycarpaea aurea* with respect to yellow-orange color of sepals but differs with respect to stipules (oblong, parted into 3 with a long acicular structure in the center and other two parts barbellate *vs.* lanceolate parted into 2, free, with no central structure), Inflorescence (dense cyme *vs.* lax cyme), bract (linear, white, acicular apex *vs.* lanceolate-ovate, greyish-brown, acuminate apex), bracteoles (Capillaceous with acicular apex *vs.* ovate lanceolate with acute apex), petals (wedge shaped, whitish-lilac *vs.* broadly ovate-oblong, yellowish-brown), Gynoecium (spheroidal, yellowish green reduced *vs.* conical, short yellow), capsule (style not persistent, tip not recurved, 2–3 seeded *vs.* style persistent, tip recurved, 5–many seeded).

Description. Annual herbs, erect or sub-erect, branched from the base 10–15 cm high. Stem terete, sparsely villous, nodes red swollen, internodes 1.5–2 cm long. Leaves whorled, sessile, lanceolate-oblancheolate, green, 1.3–2.1 cm long, base round, margin smooth or wavy, apex acute or acuminate, abaxial surface glabrous, adaxial surface pubescent; lamina 1–2 veined, prominent on abaxial side; stipules prominent, oblong, parted into 3 (2 equal barbellate parts), central part has a long acicular structure ca. 1 mm long, fused at the base (1–1.2 × ca. 0.4 mm), base golden yellow, smooth; margin entire, apex acicular, milky white. Inflorescence terminal, branched regular dense cyme, ca. 4.5 cm long; Bracts linear–lanceolate, 0.8–1.0 mm, white, equal or sub-equal to the length of the sepal; base smooth, margin entire, apex acicular. Bracteole capillaceous with acicular apex, holding the bracts in position. Flowers 4–6 per cyme, 3.5–3.8 mm long; pedicels 1.5–2.3 mm long, green villous. Sepals 5, fused at base, ovate (1–1.2 × ca. 0.8 mm), entire at the margin, acute to obtuse at apex, white, non-membranous base round, midrib faint. Petals 5, broadly wedge shaped (0.5–1 × 0.5–0.6 mm), margin entire, completely enclosing the ovary, 1/3 as short as sepals, whitish-lilac. Stamens 5, forming a ring with petals and encircling the ovary, ca. 0.9 mm long; anthers yellow, ovate, basifixed. Ovary 1-loculed, shortly stipitate, spheroidal, yellowish green, 1.2–1.3 × 1–2 mm, glabrous, placentation free central; style 0.01–0.03 mm, shorter than the ovary; stigma capitate. Capsule oblate-prolate (1.4–1.6 × ca. 0.6 mm), shortly stipitate, style not persistent, tip not recurved, 3-valved, breaks along the suture, brownish, scarious along margin. Seeds (2–3) ovate (0.1–0.15 × 0.1–0.2 mm), yellow with striations.

Micromorphology of the seed is ovate-sub-orbicular in its outline with depressions all over the seed surface. The margin is entire and the epidermal cell pattern is faintly angular. Striations are also faint (Fig. 7I, J).

Phenology. Flowering and fruiting during August–December.

Etymology. Latin barba, stiff hairs, suffix ella, diminutive, and -ata, possession, alluding to barbellate nature of stipules, a diagnostic character.

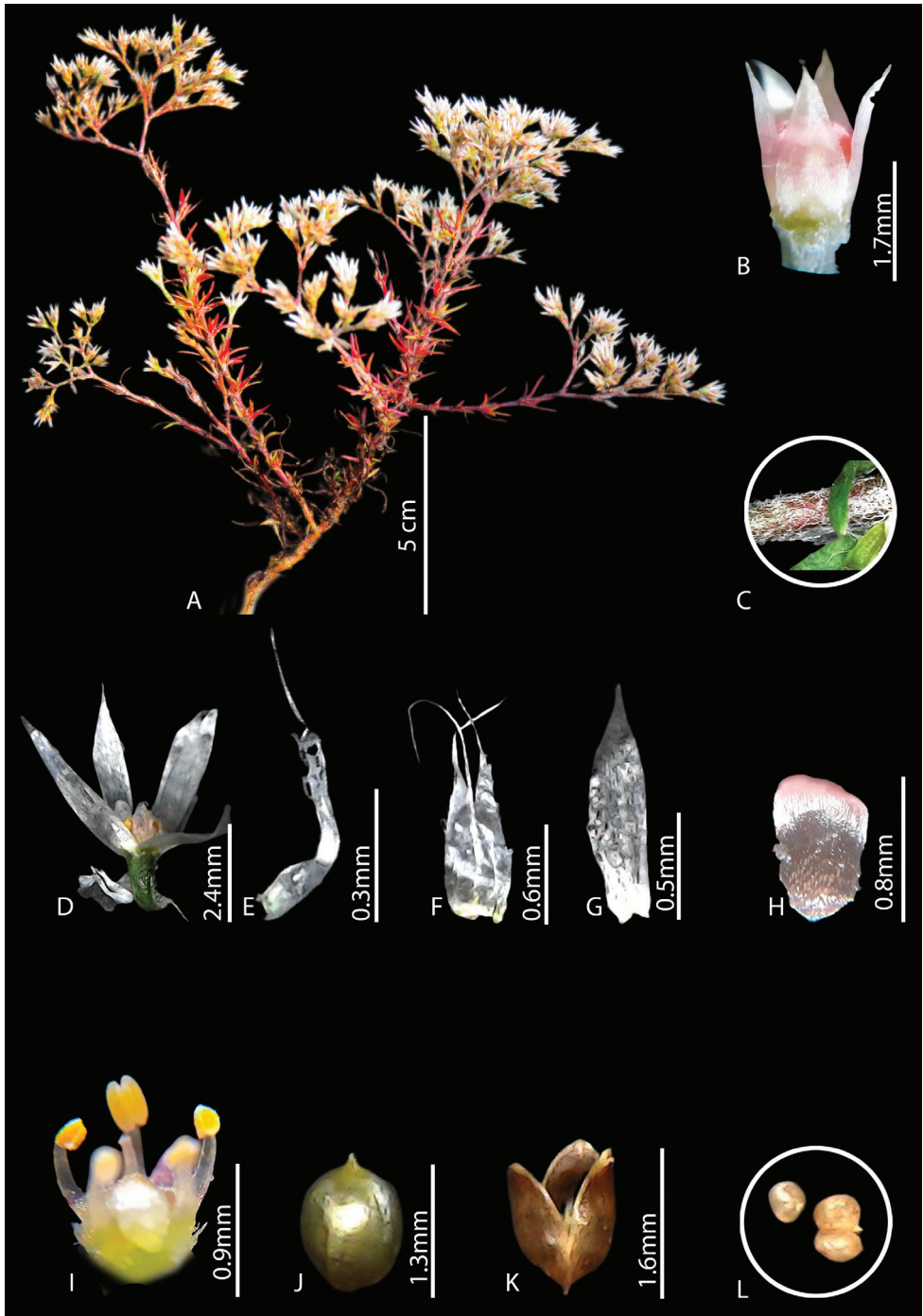


Figure 5. **A** habit **B** flower bud **C** internode **D** flower **E** bract **F** stipule **G** sepal **H** petal **I** stamen **J** gynoeceum **K** capsule **L** seed. Photos by V.S.A. Kumar.



Figure 6. *Polycarpaea barbellata* **A** habit **B** flower bud **C** flower **D** capsule **E** bract **F** stipule **G** petal **H** stamen **I** gynoecium **J** seed. Illustration by Ambika Viswanathanpillai.

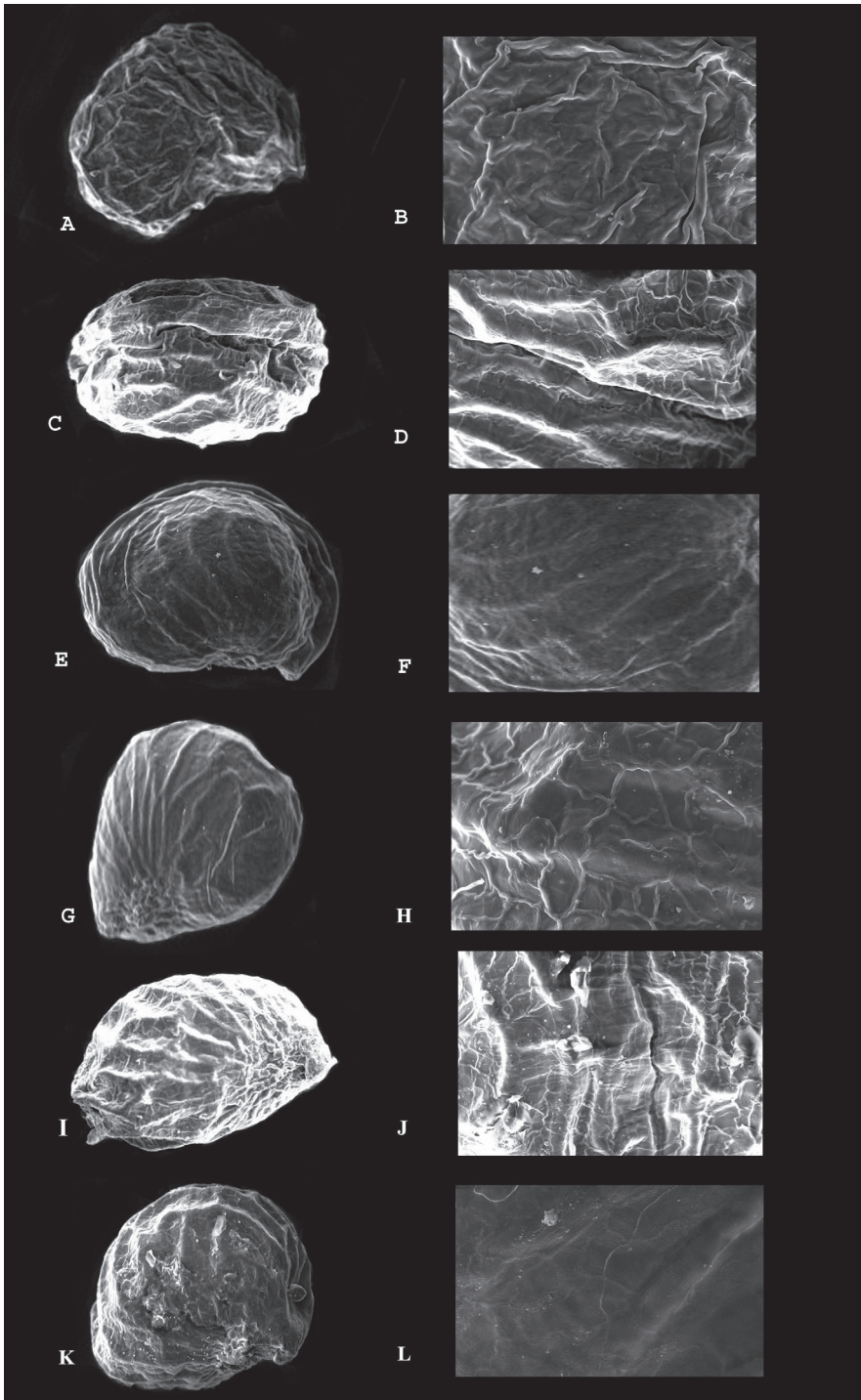


Figure 7. SEM of seeds (*P.corymbosa*) **A** seed **B** seed surface **C, D** *P. palakkadensis* **E, F** *P. ebracteata* **G, H** *P. psammophila* **I, J** *P. barbellata* **K, L** *P. aurea*.

Habitat and distribution. The primary habitat of *Polycarpaea barbellata* is the hillock terrains in Palakkad district (Kerala granite outcrop in the northern side of Palakkad gap, the largest break in the Western Ghats having an arid climate with seasonal fires). *Polycarpaea barbellata* is also seen associated with *Polycarpaea corymbosa*, *Fimbristylis* sp. and *Indigofera enneaphylla* (Fig. 8).

Conservation status. The present study could report two populations with 20–35 individuals each. We consider that further evidence is needed to determine the new taxon's conservation status because *Polycarpaea barbellata* could be found in other regions in Southwest (and India as a whole). As a consequence, the new species is now categorized as DD (Data Deficient) by the IUCN (IUCN 2021).

Additional specimens examined. INDIA. Kerala, Palakkad district, Kuzhalmanam, Kariyanchirachola, 2 November 2021, Suresh V. & Sojan Jose, 3077 (UCBD!); 10 November 2021 Alen Alex Philip & Suresh V., 3084 (UCBD!).

Taxonomic notes. In India, the genus *Polycarpaea* is represented by seven species (Arya et al. 2021). The proposed three new species are closely allied to *Polycarpaea corymbosa* (Linnaeus 1753: 205) Lamarck (1792: 129) and *Polycarpaea aurea* that has wide distribution along with *P. palakkadensis*. The new species also resembles *Polycarpaea palakkadensis* superficially but differs distinctly with respect to characters summarized in Table 1.

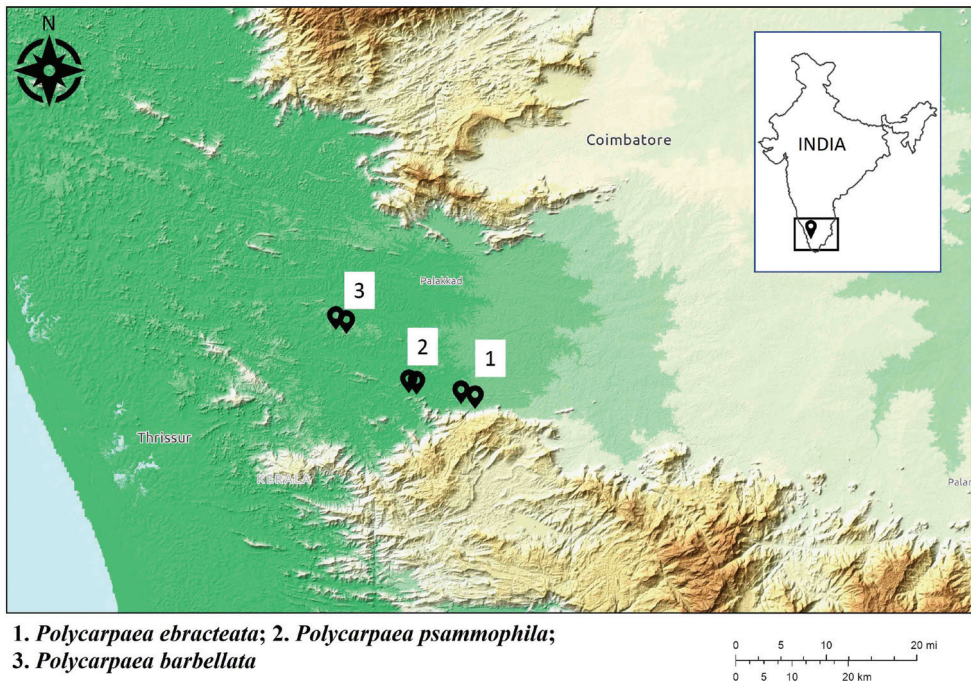


Figure 8. Distribution map of *Polycarpaea ebracteata*, *P. psammophila* and *P. barbellata*.

Table 1. Morphological comparison between *Polycarpaea ebracteata*, *P. psammophila*, *P. barbellata* with *P. corymbosa*, *P. aurea* and *P. palakkadensis*.

Characters	<i>Polycarpaea ebracteata</i>	<i>Polycarpaea psammophila</i>	<i>Polycarpaea barbellata</i>	<i>Polycarpaea corymbosa</i>	<i>Polycarpaea palakkadensis</i>	<i>Polycarpaea aurea</i>
Leaves	Verticillate	Whorled	Whorled	Opposite or apparently whorled	Verticillate (erroneously given as Pseudoverticillate in Protologue)	Opposite decussate
Stipules	Ovate-obovate, 0.2–0.8 mm, apex acute base yellowish or greenish, setae absent, white	Linear to Lanceolate, 5–8 mm, base golden yellow with unicellular setae, apex often bifurcated, branches acicular at apex, milky white	Oblong, parted into 3 (2 equal parts), central part has a long acicular structure ca 1 mm long, fused at the base 1–1.2 × ca. 0.4 mm, base golden yellow, , apex acicular, milky white	Lanceolate, long, 5 mm, base without setae, hyaline	Linear-lanceolate, 1.2 – 2 mm, base without setae, apex acute, creamy white	Lanceolate, acuminate at apex, ca. 3 mm long, base without setae, colourless or yellowish-brown, slightly silvery
Inflorescence	Regular branched lax cyme	Irregular branched lax cyme	Regular branched dense cyme	Irregular branched dense cyme	Irregular, dense cyme	Regular lax cymes
Bract	Absent	Lanceolate-oblancoate, exceeding the length of the sepal; base smooth, margin entire, apex acuminate.	Lanceolate, equal or sub-equal to the length of the sepal; base smooth, not fused.	Lanceolate-ovate, shorter than the sepal.	Ovate-oblong (erroneously given as linear-lanceolate in protologue), fused at the base, creamy white.	Ovate-lanceolate, not fused at base, grey with a faint brownish tinge.
Bracteole	Absent	Linear with acicular apex	Capillaceous with acicular apex	Lanceolate with acute apex	Capillaceous, not prominent	Ovate-lanceolate
Sepal	Ovate 1.3–1.4mm, entire at the margin, acute or obtuse at apex, white, non-membranous base round, midrib faint.	Obovate-oblancoate 2.3 –2.6 mm, acute or obtuse at apex, white.	Ovate 1–1.2 mm, acute to obtuse at apex, white, non-membranous base round, midrib faint.	Lanceolate, acuminate apex, hyaline, membranous.	Ovate-oblong, entire margin, acute or blunt apex, white.	Ovate-lanceolate, acute-acuminate at apex, scarios, bright orange-reddish.
Petal	Ovate 0.1–0.3 mm, oblong to round at apex, partially enclosing the ovary, 1/4 as short as sepals, dark red-brown.	Ovate-oblate 1–1.3 mm, keeled, pointed upward at apex, partially or completely enclosing the ovary.	Broadly wedge shaped 0.5–1 mm completely enclosing the ovary, 1/3 as short as sepals, whitish-lilac.	Broadly ovate round at apex; silvery white to pink or purplish red.	Ovate-cordate, fimbriate margin, round to mucronate at apex, dark red – brown.	Oblong-obovate, margin entire, obtuse at apex, yellowish-brown.
Stamens	0.2 mm long, filament inconspicuous	0.3 mm long; filament longer than anther.	0.9 mm, filament same length as anther.	2 mm, Filament equals the length of anther.	0.1 mm, filament very short	1 mm, filament as long as anther
Gynoecium	Spheroidal	Spheroidal	Spheroidal	Ovoid	Oblate spheroid	Conical
Capsule	Style not persistent ovoid 3-valved, breaks along the suture, brownish,	Style persistent, Oblate-prolate, tip not curved after dehiscence 4 valved.	Style not persistent, 3 valved, tips straight after dehiscence	Style persistent, tips not curved, 3 valved	Style not persistent, 4 valved, smooth, tips not recurved after dehiscence	Style persistent smooth, shining, glabrous, tips recurved after dehiscence
Seed	3–4 seeds, yellow to brown no striation	20–25 seeds yellowish brown, smooth	2–3 seed, ovate yellow with striations	5–13, brown, reniform	1–2 Ovoid-elliptical creamy white	5-many seeded, reniform brown

A key to demarcate the new three species from the other seven species found in India

- 1 Habitat in rocky terrains, reaching a height of 2–15cm, petal ovate – oblong, apex obtuse or round, not keeled **2**
- Habitat in sand, reaching a height of 18–25cm, petal ovate-oblate, apex shortly acicular, keeled *P. psammophila*
- 2 Leaves radical and cauline; flowers in spike; capsule thin walled *P. spicata*
- Leaves cauline; flowers in dense or lax cyme; capsule thick walled **3**
- 3 Bract present **4**
- Bract absent *P. ebracteata*
- 4 Petal pinkish-purple; plant glabrous *P. diffusa*
- Petals pinkish-yellow or whitish-lilac or yellowish-brown; plant densely tomentose **5**
- 5 Stem with greyish hairs; petal lightly coloured or hyaline; leaves set with green slender node *P. corymbosa*
- Stem with white hairs; petal brightly colored; leaf set with reddish swollen nodes **6**
- 6 Plants not stunted; sepal bright white or red or orange; petals yellow-brown or whitish lilac **7**
- Plants stunted; sepal colorless; petals violet *P. majumdariana*
- 7 Leaves opposite-decussate; anthers white-cream *P. aurea*
- Leaves pseudo whorled, whorled or verticillate, nodes red villous, anthers bright yellow **8**
- 8 Stipule barbellate parted into three halves with central part acicular *P. barbellata*
- Stipules smooth parted into two halves with no central structure **9**
- 9 Sepals ovate-oblong; petals ovate-cordate, apex round; gynoecium oblate spheroidal, capsule 1–2 seeded, seed ovoid *P. palakkadensis*
- Sepals lanceolate, petals ovate-lanceolate, apex acute; gynoecium prolate; capsule 3–10 seeded, seed sub-reniform *P. rangaiabiana*

Acknowledgements

The authors express gratitude to the Directors and Curators of the National herbaria cited. The authors would also like to acknowledge Ms. Neeraja Rajesh, Medical Scribe, Florida, United States for her meticulous checking of the syntax of this manuscript as a native English expert. The first author is grateful to University of Kerala for financial assistance, Head of the Department of Botany, University College and to the Principal, University College, Thiruvananthapuram for providing facilities. The corresponding author expresses his gratitude to the Director of Collegiate Education, Government of Kerala, for providing facilities. All authors extend their gratitude to the Kerala Forest Department for granting permission to do research work in the forest regions of Kerala.

The authors also express their gratitude to the Central Laboratory for Instrumentation and Facilitation, University of Kerala, Kariavattom.

References

- Arya S, Kumar VNSA, Nathanpillai AV, Philip AA, Sojan J, Suresh V (2021) *Polycarpaea palakkadensis* (Caryophyllaceae), a new species from Kerala, South-West India. *Phytotaxa* 527(2): 151–157. <https://doi.org/10.11646/phytotaxa.527.2.8>
- Daniel P (2005) The Flora of Kerala, vol. I. Botanical Survey of India, Kolkata, 312 pp.
- Daniel P, Venu P, Muthukumar SA, Thiyagaraj GJ, Malathi CP (2000) A taxonomic reassessment of the genus *Polycarpaea* Lam. (Caryophyllaceae) in India. *The Swamy Botanical Club* 17: 3–12.
- Dequan L, Gilbert MG (2001) *Polycarpaea* Lamarck. In: Wu Z, Raven PH (Eds) *Flora of China* (Caryophyllaceae-Lardizabalaceae), vol. 6. Science Press and St Louis, Missouri, USA: Missouri Botanical Garden Press, 1–113.
- Dunn ST (1915) Ranunculaceae to Opiliaceae. In: Gamble JS (Ed.) *Flora of the Presidency of Madras*, vol. I. Allard & Son, London, 1–200.
- Edgeworth MP, Hooker JD (1874) Caryophyllaceae in: Hooker JD (Ed.) *The Flora of British India*, L. Reeve & Co., London, 212–246.
- Geethakumary MP, Deepu S, Viji AR, Pandurangan AG (2019) A new species of *Polycarpaea* (Caryophyllaceae) from India. *Phytotaxa* 414(4): 181–186. <https://doi.org/10.11646/phytotaxa.414.4.4>
- IUCN (2021) Guidelines for using the IUCN Red List Categories and Criteria. Version 11. Prepared by the standards and petitions subcommittee. <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> [accessed 12 September 2021]
- Lamarck JB (1792) Sur le nouveau *Polycarpaea*. *Journal d'Histoire Naturelle* 2: 3, 5, 478.
- Linnaeus C (1753) *Species plantarum* 2. Laurentii Salvii, Holmiae, 899 pp.
- Mabberley DJ (2008) *Mabberley's plant-book: a portable dictionary of plants, their classifications, and uses*. Cambridge University Press, Cambridge, 1021 pp.
- Majumdar NC (1993) Caryophyllaceae. In: Sharma BD, Balakrishnan NP (Eds) *Flora of India*, vol. 2. Botanical Survey of India, Calcutta, 502–595.
- Mastakar VK, Lakshminarasimhan P, Modak M (2015) A report on the extended distribution of *Polycarpaea aurea* (Caryophyllaceae), An endemic herbaceous species to Chota Nagpur Plateau, Jharkhand, India. *Journal of Threatened Taxa* 7(12): 7950–7952. <https://doi.org/10.11609/JoTT.o4268.7950-2>
- Thiers B (2021 [continuously updated]) *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. <https://sweetgum.nybg.org/ih> [accessed 13 September 2021]
- Venu P, Muthukumar SA, Daniel P (2001) *Polycarpaea majumdariana* (Caryophyllaceae) – a new species from Tamil Nadu, India. *Nordic Journal of Botany* 21(6): 577–579. <https://doi.org/10.1111/j.1756-1051.2001.tb00813.x>
- Wight R (1843) *Icones Plantarum Indiae Orientalis*, Vol. II. J. B. Pharoah, Madras, 33 [explanations] + 417 [plates].
- Wight R (1850) *Illustrations of Indian Botany*, vol. II. American Mission Press, Madras, 230 pp.