



<https://doi.org/10.11646/bde.46.1.8>

## *Acidodontium indicum* (Bryaceae: Bryophyta)—a new species from the Western Ghats of India

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### Abstract

*Acidodontium indicum* sp. nov. (Bryaceae), is described and illustrated from the Western Ghats of Kerala. Since the genus has not been reported from India, it represents a new generic record as well. The species is compared with *Acidodontium megalocarpum* (Hook.) Renauld & Cardot and *A. exaltatum* (Spruce ex Mitt.) A. Jaeger. *Acidodontium indicum* is distinguished by small broadly lanceolate to more or less spatulate leaves having a strong, short excurrent costa, margin completely entire, bordered by 1–4 rows of long incrassate cells, short setae, capsule clavate with short apophysis, operculum conic without apiculus and endostome with high basal membrane and forked endostome segments diverging at a different angle.

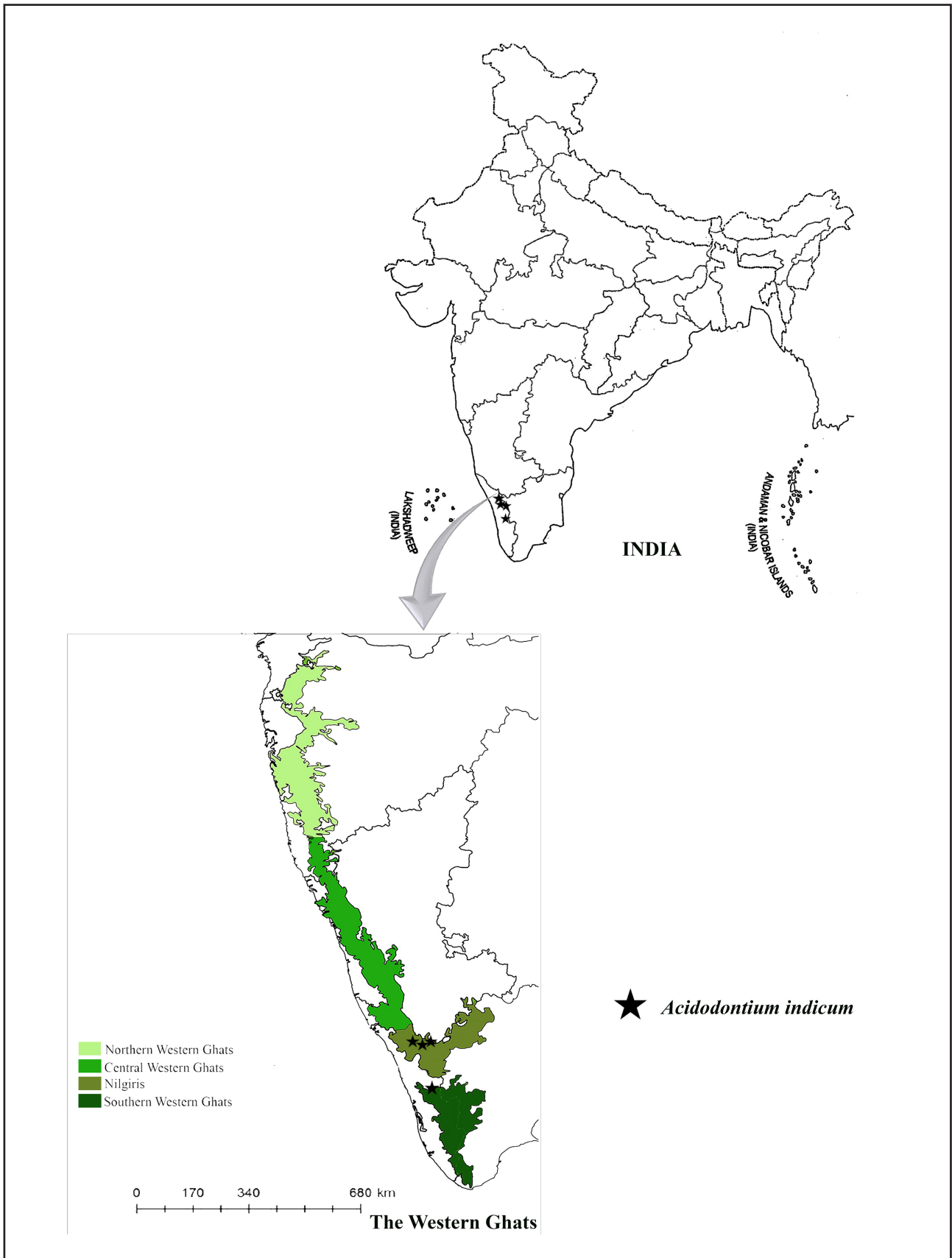
**Key words:** *Acidodontium indicum*, India, Palakkad, New species, Wayanad, Western Ghats

### Introduction

The Bryaceae is a large cosmopolitan moss family and is known for its identification difficulties as well as controversial generic classification. Of the recognized genera, the least studied is *Acidodontium* Schwägrichen (1827: 152) (Type species, *Acidodontium megalocarpum* (Hook. in Kunth 1822: 59) Renauld & Cardot (1893: 162)). Ochi (1980) described and illustrated 11 species of *Acidodontium* but indicated that several Type specimens could not be located. There are 16 accepted names but until the genus is fully monographed we will not know how many species exist. One of the more surprising results of the molecular studies is that the genus appears to be most closely related to *Anomobryum* Schimper (1860: 382) and *Haplodontium* Hampe (1865: 336), despite significant morphological differences (Pedersen *et al.* 2006). *Acidodontium* is Neotropical in distribution, concentrated in the Andes of South America, with extensions to Central America and the Caribbean. Most species are epiphytic growing on twigs, branches and tree trunks at middle to high elevations. The genus exhibits widely divergent gametophyte morphologies but is characterized by an apparent apomorphy in the peristome where the endostome processes in the upper 1/3–1/4 split along the keel and diverge at various angles depending on the species (Shaw 1985).

Field work and taxonomic revisions have added numerous new species in the family, even from well-studied regions such as the western Palearctic and California. However, the discovery of a species new to science in *Acidodontium* in southern India is unexpected and represents a significant range extension outside of the Neotropics.

During our recent bryofloristic survey in the Nelliampathy hills of Palakkad district and in the Wayanad district in the Western Ghats of India, we came across an interesting species growing on a wide variety of substrates and found that the genus is not reported from India and is here described as *Acidodontium indicum* sp. nov. (Figure 1).



**FIGURE 1.** *Acidodontium indicum* Vineesha, Sajitha, Manju & J.R. Spence **sp. nov.** Collection site in the Western Ghats of Kerala, indicating the extend of the mountain systems in the western coast of India. Grey lines: State borders.

## Materials & Methods

Morpho-anatomical analysis of fresh and herbarium specimens were studied using stereo dissection microscope (Leica Model: S Apo Stereozoom 1.0x–8.0x) and compound microscope (Olympus CX2LiLED). Measurements of the plant parts and cells were taken with the help of Magnus Analytics MagVision (version: x64, 4.8.15674.20191008) software. The free hand sections of the plants were made using normal razor blades under a dissecting microscope, and viewed under a compound microscope. Digital images were taken using the digital image recording facility attached to the microscopes. The freshly collected specimens were dried, placed into herbarium packets and deposited in the University of Calicut Herbarium (CALI).

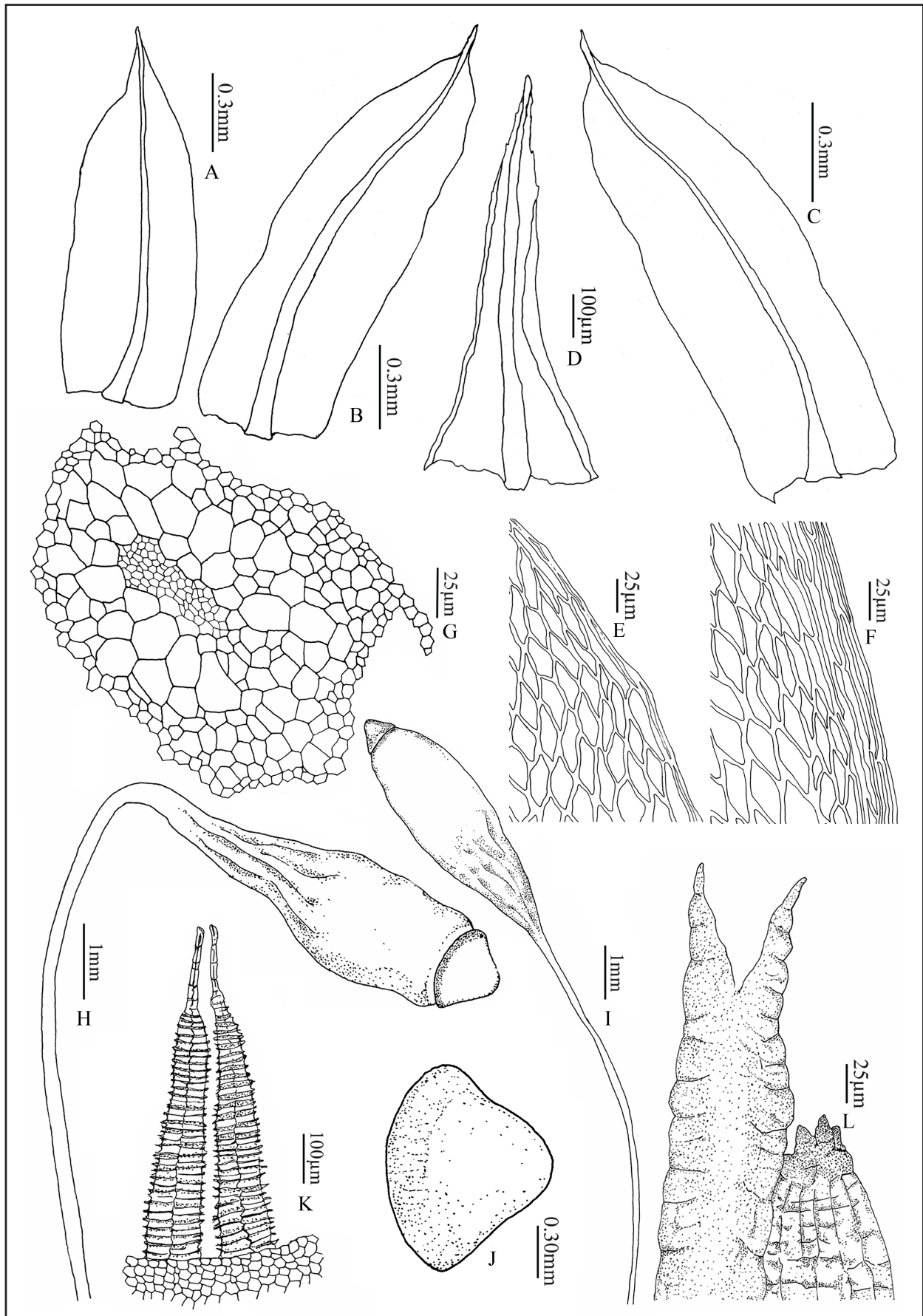
## Taxonomic treatment

*Acidodontium indicum* Vineesha, Sajitha, Manju & J.R. Spence **sp. nov.** Type:—INDIA. Kerala: Palakkad Dist., Nelliampathy Hills, Way to Minnampara, terricolous, 1000 m alt., 10°32'16" N, 76°43'42" E, 30 October 2011, *Maya C. Nair 10467* (Holotype: CALI, Isotype: BSI) (Figures 2&3)

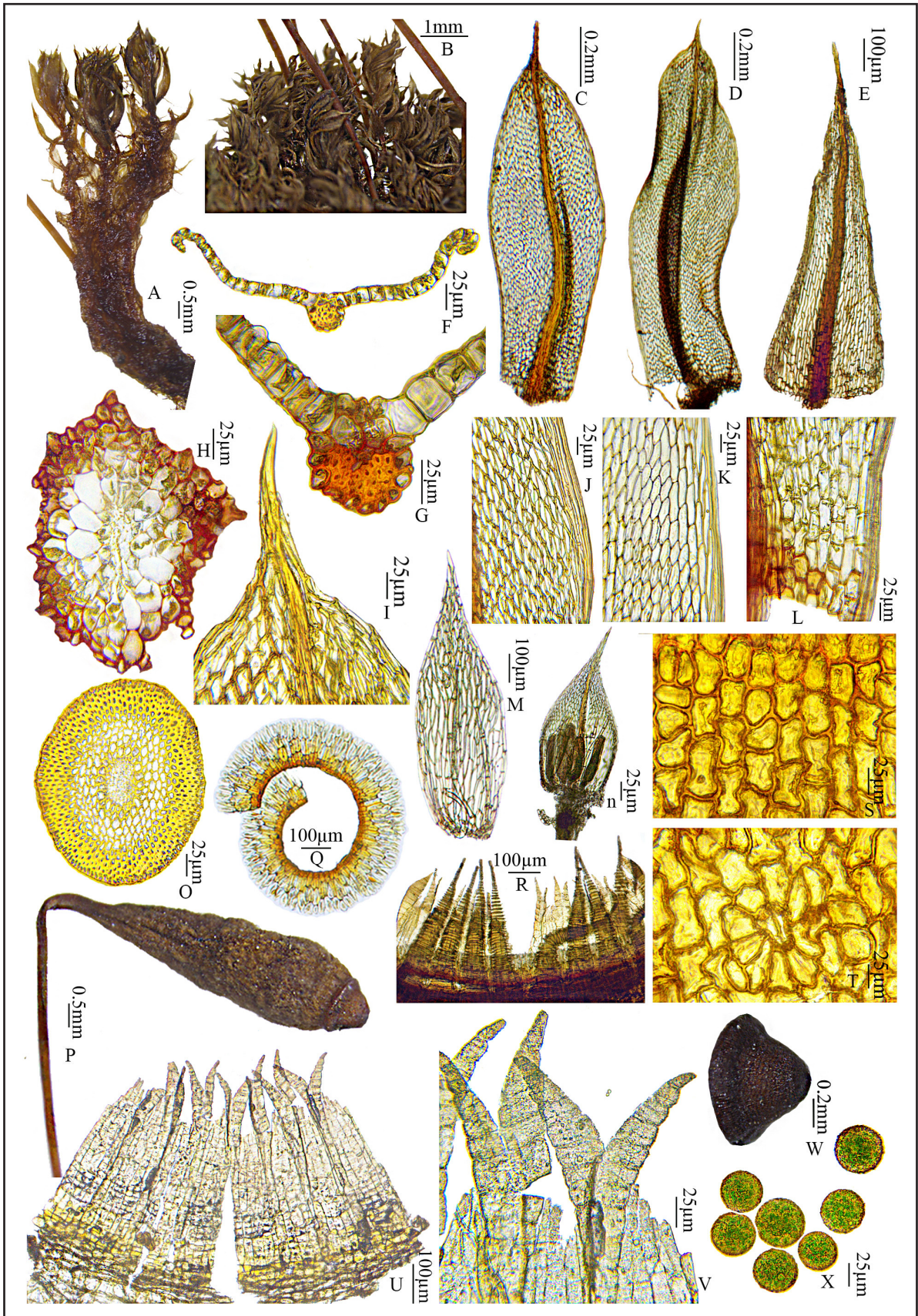
Diagnosis:—Characterized from *Acidodontium megalocarpum* by the much smaller leaves, broadly lanceolate to spathulate, costa short excurrent, 0.1–0.2 mm long, seta short, 2.3 mm, capsule clavate with short apophysis, operculum conic without apiculus, endostome with high basal membrane, forked endostome segments diverge at a different angle and cilia none or highly rudimentary.

Plants dioicous, growing caespitose, preferring a wide variety of substrates on soil covered rocks, land cuttings and on bark of trees, yellowish green, height up to 1.5 cm; stem erect, red-brown, highly radiculose except at the tip, 3–4 lateral innovations, rounded to polygonal in cross section, 0.15–0.20 mm diameter, uniseriate epidermis of thick walled cells, 7–6  $\mu\text{m}$  wide, cortical cells thin, polygonal, 3–4 layered, 11–25  $\mu\text{m}$  wide, central strand with thin walled medullary cells, small, 1.5–4  $\mu\text{m}$ , rectangular to polygonal; leaves very small, crowded near the tip, flexuous when dry, spirally arranged along the stem, broadly lanceolate to more or less spathulate, 1.25–2.2 mm long, 0.3–0.5 mm wide, tip acuminate with short excurrent, aristate costa, distinct leaf margin composed of 1–4 rows of long, thick walled cells, 98–120  $\times$  1–4.5  $\mu\text{m}$ , revolute except at 1/4<sup>th</sup> portion near tip where it is entire, cells porose, proximal cells rectangular, 17–60  $\times$  8–18.5  $\mu\text{m}$ , median cells long rhomboid hexagonal, 34–54  $\times$  8–16  $\mu\text{m}$ , distal cells rhomboid, 26–43  $\times$  6–15  $\mu\text{m}$ ; costa strong, prominent, in cross section with stereids; rhizoids dense, cover the stem up to comal tip of the plant, form brown tangled mass, rough surface with minute papillae; perichaetial leaf lanceolate, perigonal leaf ovate with acuminate tip, paraphyses pale pink to pale yellow in colour, 4–5 celled; seta yellow to brown, twisted, bent near the neck of the capsule, 1.5–2.3 cm long, in cross section 0.19–0.23 mm diameter, outer 3–5 layers of thick walled stereid cells give strength to the seta, golden yellow in colour, cortical cells comparatively thin, polygonal and 3–4 layered, innermost cortical cells again increased in thickness and border the central strand formed of very small, thin, delicate mass of cells; capsule horizontal to nutant, deep brown, clavate, 3.5–5.3  $\times$  0.7–1.5 mm (with operculum), slender, apophysis rugose when dry, symmetrical mouth, operculum conical, without apiculus, 0.7–0.9 mm diameter at mouth, 0.4–0.7 mm height from mouth, peristome teeth diplolepidous, exostome articulated, broad at base, abruptly acuminate towards tip, tip with hyaline and papillose, endostome well developed segments with high basal membrane (0.3–0.5 mm), segment parted along the keel to two lobes to form divergent tips (ie, forked segments), cilia rudimentary, exothecial cells polygonal with intact cell walls up to 4–6 layers near mouth of the peristome, 10–27  $\times$  7–33  $\mu\text{m}$ , and other cells with thick repand cell walls, 12–34  $\times$  23–80  $\mu\text{m}$ , presence of phaneropores, spores round, pale yellow to green, strongly roughened with papillose surface, 30–50  $\mu\text{m}$ .

**Distribution and ecology.** Seen on a wide variety of substrates such as on soil covered rocks, land cuttings, on the bark of trees and on tea plants at an elevation around 800–1000 m. It is found in semi evergreen and evergreen forests, associated with other bryophytes such as *Archilejeunea minutilobula* Udar & Awasthi (1981: 18), *Erythrodontium julaceum* (Schwägrichen 1828: 245) Paris (1895: 112) and *Frullania muscicola* Stephani (1894: 146).



**FIGURE 2.** *Acidodontium indicum* Vineesha, Sajitha, Manju & J.R.Spence **sp. nov.**, A–C. Stem leaves, D. Perichaetial leaf, E. Leaf margin near tip, F. Leaf margin at median part, G. Stem cross section, H–I. Capsule, J. Operculum, K. Exostome teeth, L. Forked endostome segments with rudimentary cilia (Illustration by Vineesha P.M.).



**FIGURE 3.** *Acidodontium indicum* Vineesha, Sajitha, Manju & J.R.Spence **sp. nov.**, A. Habit with lateral innovations, B. Dry habit, C–D. Stem leaves, E. Perichaetial leaf, F. Leaf cross section, G. Costa cross section, H. Stem cross section, I. Leaf tip with excurrent costa and cells, J. Leaf marginal cells, K. Median leaf cells, L. Leaf basal cells, M. Perigonial leaf, N. Perigonium with antheridium and paraphyses, O. Seta cross section, P. Capsule, Q. Annulus, R. Peristome teeth, S. Exothecial cells, T. Phaneropore, U–V. Forked endostome teeth, W. Operculum, X. Spores (Photos by Vineesha & Sajitha).

**Other specimens examined.** INDIA. Kerala: Palakkad Dist., Nelliampathy Hills, on bark of tea plant (990 m elev.), 10°32'15" N, 76°43'40" E, 29 August 2022, *Sajitha Menon S. 194358* (CALI); 26 March 2022, *Vineesha, P.M. 16902* (CALI). Wayanad Dist., 900 Kandi (1183 m elev.), 11.5020° N, 76.1104°E, 10 June 2023, *Mufeed B. 195180* (CALI); Kattikulam, Cherur (819 m elev.), 11°50'2" N, 76°2'48" E, 22 August 2023, *Vineesha P.M., 194726* (CALI). Kozhikode Dist., Kuttiady Churam (890 m elev.) 11.6543°N, 75.7535°E, 08 July 2023 *Manju C.N., 202160* (CALI).

This species forms tufted mats and grows on a wide variety of substrates including on soil covered rocks, on land cuttings and on the bark of trees. It resembles *Acidodontium megalocarpum* in its acuminate, limbate leaves and clavate capsule, but differs in having short broadly lanceolate to more or less spatulate leaves with a strong, short excurrent costa, margin completely entire, and lamina bordered by 1–4 rows of long incrassate cells. Setae are short (up to 2.3 cm only), capsule clavate with short apophysis, operculum conic without apiculus and an endostome with high basal membrane, and forked segments which diverge at a different angle. *Acidodontium exaltatum* (Spruce ex Mitten) Jaeger (1875: 110), is a similar species with finely apiculate or non-apiculate operculum, short setae (2.5 cm) and clavate capsule. It differs from the new species as it possesses ovate or oblong leaves, serrulate, narrowly bordered leaf margin (1–2 rows), capsule with long, slender apophysis and smaller spores (22–26 µm). Table 1. Shows the comparison of characters of three species *A. indicum*, *A. megalocarpum* and *A. exaltatum*.

## Etymology

The species is named after its Type locality, India.

## Discussion

As noted, the new species appears to be most closely related to *A. megalocarpum*, which is a problematic species as Ochi (1980) discussed high variability in its range, implying that perhaps more than one distinct taxon exists. Since there have been no recent studies on the genus, it is entirely possible that *A. indicum* might represent one aspect of this variation. This would provide support for the hypothesis that the species is a naturalized introduction to southern India. The presence of *A. indicum* in natural relatively undisturbed forest reserves in the Western Ghats suggests however that it could be a native species.

There remain at least three additional hypotheses based on *A. indicum* being a native species that evolved in India. West Gondwanaland during the late Cretaceous and early Cenozoic included Antarctica, Australia, India and South America. With plate tectonic rafting over the Cenozoic, it is possible that ancestors to the genus were more widely distributed, but eventually became extinct in Antarctic from glaciation and in Australia following long-term increasing aridity. Alternatively, it is possible that additional *Acidodontium* species might still exist in higher elevations in eastern Australia or potentially New Guinea. Epiphytic species are often hard to find and difficult to collect if they occur in high canopies. Also, epiphytic Bryaceae are relatively rare.

Perhaps the most intriguing hypothesis is that *Acidodontium* is not monophyletic, implying that the shared apomorphy of the split endostome processes (see Shaw 1985; Pedersen et al. 2006 on monophyletic status) evolved independently in unrelated lineages and is the result of convergence, perhaps related to the epiphytic habitats of many of the species. Ochi (1980) documented the high morphological diversity in the gametophytes of the 11 species he recognized. Thus *A. indicum* may represent a different lineage than the Neotropical species. Without further field and monographic work combined with molecular studies, this hypothesis cannot be tested at this time.

There are no other specific disjunct distributions between India and South America in the Bryaceae. Several pantropical species are found in both regions, such as *Gemmabryum apiculatum* (Schwägr.) J.R. Spence & H.P. Ramsay (2005: 65), *Gemmabryum coronatum* (Schwägr.) J.R. Spence & H.P. Ramsay (2005: 66), and *Plagiobryoides cellularis* (Hook.) J.R. Spence (2009: 499). Interestingly, there is a weak connection between Australia and India, with *Brachymenium lanceolatum* Hook. f. & Wilson (1860: 188) and *Rosulabryum wightii* (Mitt.) J.R. Spence (1996: 223) which are disjunct, and without any intermediate localities. It is thus possible that the genus *Acidodontium* may eventually be found in the Australasian region.

*Acidodontium* is not known from Australasia or southeast Asia (Ochi 1985, Spence & Ramsay 2019). However, this is not the first report of the genus outside the Neotropics, as Suzuki (2014) listed two species from Japan, *A. megalocarpum* and *Acidodontium longifolium* (Schimp. ex Paris) Brotherus (1903: 561). The latter does not have

the distinctive split endostome, has different leaf morphology and may be a species of *Mielichhoferia* Hornschuch (1831: 179) or *Pohlia* Hedwig (1801: 171). His photograph of *A. megalocarpum* is somewhat ambiguous, as it is difficult to determine if the endostome split processes are natural or as a result of tearing and damage during specimen preparation, and also appear to lack the typical curvature found in other species. The reported spore size is also much smaller than typical *A. megalocarpum*. These specimens require additional study to determine their status. If they are related to the Neotropical species of *Acidodontium* it suggests the genus is more widespread than previously thought and is either under collected or possibly not recognized as that genus in existing collections.

**TABLE 1.** Comparison of characters of *A. indicum*, *A. megalocarpum* and *A. exaltatum*.

Characters	<i>A. indicum</i>	<i>A. megalocarpum</i>	<i>A. exaltatum</i>
Habitat	Epiphytic on tree bark and terrestrial on soil covered rock.	On tree bark, rarely on ground	On bark of trees
Leaf shape	Broadly lanceolate to spatulate	Oblong or obovate-oblong	Ovate-oblong
Leaf margin/border	Entire, distinctly bordered, 1-4 layered	Nearly entire to finely crenulate, distinctly bordered, 2-3 layered	Serrulate, narrowly bordered, 1-2 layered
Costa	Strong, short excurrent, non-denticulate tip	costa not strong, long-excurrent, flexuous, denticulate tip	Short excurrent
Length of seta	Short, 2.3 cm	Up to 3.5 cm, rarely up to 5 cm	Short, 2.5 mm
Shape of capsule	Clavate with short apophyses	Long, clavate with short to long apophyses	Clavate with long slender apophyses
Capsule operculum	Short conic, non-apiculate operculum	Large hemispherical, apiculate-operculum	finely apiculate or non-apiculate operculum
Spore size	30–50 µm	According to Ochi (1980) various collections show a range of 20–53 µm.	22–26 µm

## Acknowledgements

Vineesha and Sajitha are thankful to the University Grants Commission (UGC), and CSIR-New Delhi respectively for the financial assistance under NET-JRF scheme. The authors are thankful to the authorities of the University of Calicut for the infrastructure facilities provided. Manju CN is thankful to the University of Calicut for funding minor Research Project utilizing Seed Money and to the SERB, DST (Department of Science and Technology) New Delhi for funding Core Research Grant in the Department of Botany, University of Calicut. We also thank the Kerala Forest & Wildlife Department for the permission to collect species and to its staff members for the support during the field studies. We are grateful to the reviewers for their valuable suggestions for improving the manuscript.

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