

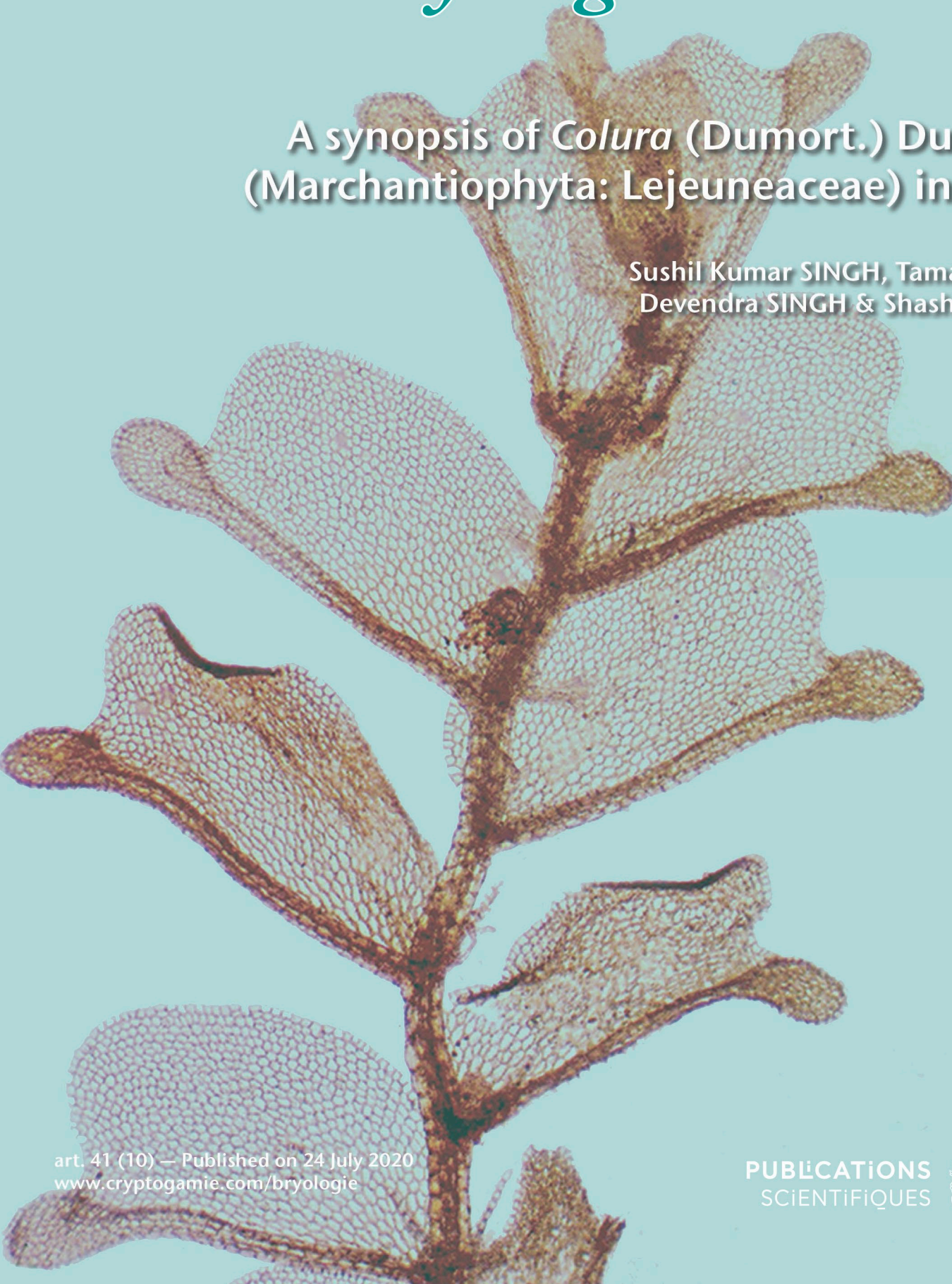
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Bryologie

2020 • 41 • 10

A synopsis of *Colura* (Dumort.) Dumort.
(Marchantiophyta: Lejeuneaceae) in India

Sushil Kumar SINGH, Tamás PÓCS,
Devendra SINGH & Shashi KUMAR



art. 41 (10) — Published on 24 July 2020
www.cryptogamie.com/bryologie

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diff.pub@mnhn.fr / <http://sciencepress.mnhn.fr>

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ISSN (imprimé / *print*) : 1290-0796 / ISSN (électronique / *electronic*) : 1776-0992

A synopsis of *Colura* (Dumort.) Dumort. (Marchantiophyta: Lejeuneaceae) in India

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Submitted on 18 August 2018 | Accepted on 1 July 2020 | Published on 24 July 2020

Singh S. K., Pócs T., Singh D. & Kumar S. 2020. — A synopsis of *Colura* (Dumort.) Dumort. (Marchantiophyta: Lejeuneaceae) in India. *Cryptogamie, Bryologie* 41 (10): 111-129. <https://doi.org/10.5252/cryptogamie-bryologie2020v41a10>. <http://cryptogamie.com/bryologie/41/10>

ABSTRACT

The genus *Colura* (Dumort.) Dumort. is morpho-taxonomically investigated in India and eight species have been recognized mainly distributed in three different bryo-geographical regions of the country. *Colura corynophora* (Nees, Lindenb. & Gottsche) Trevis. is reported here for the first time from India, *C. leratii* (Steph.) Steph. is added to the East Himalayan bryogeographical territory, *C. acroloba* (Prantl) Jovet-Ast, *C. ari* (Steph.) Steph. and *C. conica* (Sande Lac.) K.I. Goebel are new additions to Mizoram, while *C. tenuicornis* (A. Evans) Steph. is a new report to the state of Meghalaya.

KEYWORDS

Colura,
India,
Harmophyllum,
Glotta.

RÉSUMÉ

Un synopsis du genre Colura (Dumort.) Dumort. (Marchantiophyta: Lejeuneaceae) en Inde.

L'investigation morphologique et taxonomique du genre *Colura* (Dumort.) Dumort. en Inde permet de reconnaître la présence de huit espèces distribuées dans trois différentes régions bryo-géographiques. *Colura corynophora* (Nees, Lindenb. & Gottsche) Trevis. est rapporté pour la première fois en Inde, *C. leratii* (Steph.) Steph. est à ajouter au territoire bryo-géographique de l'Himalaya Est, *C. acroloba* (Prantl) Jovet-Ast, *C. ari* (Steph.) Steph. et *C. conica* sont nouveaux pour le Mizoram, tandis que *C. tenuicornis* (A. Evans) Steph. est nouveau pour l'état de Meghalaya.

MOTS CLÉS

Colura,
Inde,
Harmophyllum,
Glotta.

INTRODUCTION

Lejeuneaceae is the largest family of Marchantiophyta with 74 genera currently accepted (Zhu *et al.* 2017, 2019). The genus *Colura* (Dumort.) Dumort. is one of large genera of the family with 83 species and two varieties (incl. two species *incertae sedis*) in the world belonging to two subgenera and six sections (Pócs & Eggers 2007; Söderström *et al.* 2016; Sangrattanaprasert *et al.* 2018). The species are abundant in tropical and subtropical regions, especially in Malesia which is considered as a hotspot (Pócs 1996; Zhu & So 2001; Sangrattanaprasert *et al.* 2017). Members of this genus are mostly foliicolous, but also grow on bark, and are characterized by the presence of tubular to cylindrical leaf lobules terminating into a sac with a valve and pore. Jovet-Ast in her revisionary work on *Colura* (Jovet-Ast 1953, 1954) recognized over 50 species in the genus. Since then, more than 30 new species are described from different parts of the world (Jovet-Ast 1957, 1958, 1961, 1968a, b, 1976, 1980, 1983; Jovet-Ast & Tixier 1958; Grolle 1965, 1969; Vanden Berghen 1972; Miller 1981; Gradstein 1986; Thiers 1987; Schuster 1992; Pócs 1993, 1995, 1997, 2011, 2013, 2015; Jones & Pócs 1987; Pócs & Eggers 2007; Müller & Pócs 2007). Also range extensions of several species have been reported in scattered publications including regional checklists (Mizutani 1961; Kitagawa 1969; Engel 1978; Onraedt 1979; Pócs 1991, 2010, 2012; Grolle 1995; Dauphin *et al.* 1998; Fischer 1999; Zhu & So 2001; Grolle & Zhu 2002; Chuah-Petiot & Pócs 2003; Chuah-Petiot 2011; Pócs & Ninh 2005, 2012; Pócs & Streimann 2006; Lai *et al.* 2008; Söderström *et al.* 2010, 2011; Hylander *et al.* 2010; Wang *et al.* 2011; Pócs *et al.* 2011, 2013; Ah-Peng *et al.* 2012; Gradstein & Benitez 2014; Long & Rubasinghe 2014; Sangrattanaprasert *et al.* 2017). But, an updated worldwide monograph of *Colura* is still lacking.

In India, the genus was first recorded by Lal (1977), who reported *Colura tenuicornis* (A. Evans) Steph. from Darjeeling in Eastern Himalaya. Since then seven species namely, *C. acroloba* (Prantl) Jovet-Ast, *C. ari* (Steph.) Steph., *C. calyptrifolia* (Hook.) Dumort., *C. conica* (Sande Lac.) K.I. Goebel, *C. leratii* (Steph.) Steph., *C. tenuicornis* (A. Evans) Steph. and *C. pluridentata* Jovet-Ast, have been reported from the country (Lal 1980, 2003; Udar & Awasthi 1985; Singh 1996; Asthana & Shukla 2010; Dey & Singh 2016; Singh & Kumar 2016; Mufeed *et al.* 2018). Earlier to the present report, majority of the species were recorded from very restricted pockets of the country, viz. *C. pluridentata* to Great Nicobar Island, *C. conica* and *C. tenuicornis* to Eastern Himalaya, *C. calyptrifolia* and *C. leratii* to Western Ghats, while *C. acroloba* and *C. ari* are distributed in Andaman and Nicobar Island (South Andaman Island) and East Himalayan bryo-geographical territories (Singh *et al.* 2016; Singh & Kumar 2016; Mufeed *et al.* 2018) and except *C. tenuicornis*, specimens are poorly represented in Indian herbaria.

In recent years, while conducting bryo-floristic surveys in North east India, especially Mizoram, one of the authors (SKS) collected several populations of the genus. The detailed morpho-taxonomic study on these specimens revealed the presence of six species in the region. Of these, *C. corynophora*

is an addition to the bryoflora of India, *C. leratii* is new to the East Himalayan bryogeographical territory, *C. acroloba*, *C. ari* and *C. conica* are new addition to the state of Mizoram, while *C. tenuicornis* is new to the state of Meghalaya. In the present study we have also attempted to study and catalogue all the materials of the genus available in Indian herbaria. Unless otherwise mentioned, the distributional data of each species have been adopted from Singh *et al.* (2016).

CONSPECTUS OF THE GENUS *COLURA* IN INDIA

Subgenus A. *Colura*

Sect. I. *Colura*

C. calyptrifolia (Hook.) Dumort.

C. tenuicornis (A. Evans) Steph.

Sect. II. *Harmophyllum* Grolle

C. ari (Steph.) Steph.

C. conica (Sande Lac.) K.I. Goebel

C. pluridentata Jovet-Ast

Subgenus B. *Glotta* Grolle & R.-L. Zhu

Sect. I. *Heterophyllum* Jovet-Ast

C. acroloba (Prantl) Jovet-Ast

C. leratii (Steph.) Steph.

C. corynophora (Nees, Lindenb. & Gottsche) Trevis.

TAXONOMIC DESCRIPTION

Family LEJEUNEACEAE
Colura (Dumort.) Dumort.

Colura acroloba (Prantl) Jovet-Ast
 (Figs 1A-P; 8A)

Revue Bryologique et Lichénologique 22: 297 (1953).

SPECIMENS EXAMINED. — **India.** Arunachal Pradesh, Tirap district Khonsa, II.1982, *K.P. Singh s.n.* (ASSAM); Mizoram, Lawngtlai, Ngengpui WLS, 22°29'49.7"N, 92°46'33.1"E, 138 m, 01.XII.2012, *S. K. Singh & Party 127584M*; Ngengpui Wildlife Sanctuary, 22°29'52.2"N, 92°45'49.1"E, 134 m, 02.XII.2012, *S. K. Singh & Party 127670A* (ASSAM); Ngengpui Wildlife Sanctuary, 22°29'50.4"N, 92°45'34.6"E, 146 m, 02.XII.2012, *S. K. Singh & Party 127680A* (ASSAM); Ngengpui WLS, 22°29'29.9"N, 92°45'22.5"E, 170 m, 02.XII.2012, *S. K. Singh & Party 127692C* (ASSAM); Tripura, Jampui Hills, Longai river side, 23°50'48.9"N, 91°57'44.7"E, 470 m, 26.X.2015, *S. Kumar TSLI-1315B, 1327C* (ASSAM).

HABITAT. — Foliicolous, growing in association with *Caudalejeunea lehmanniana*, *Cheilolejeunea trapezia*, *Cololejeunea floccosa*, *C. subfloccosa*, *Drepanolejeunea devendrae*, *D. foliicola*, *Lejeunea exilis*, *Leptolejeunea balansae*, *L. latifolia*, *L. maculata*, *L. epiphylla*, *Microlejeunea punctiformis*, in relatively less moist places at elevation of 100–200 m a.s.l.

DISTRIBUTION. — India [Andaman & Nicobar Islands, Mizoram-present study, Arunachal Pradesh-present study, Tripura (Singh *et al.* 2016)], Cambodia, China, Fiji, Indonesia, Malaysia, New Caledonia, Papua New Guinea, Philippines, Samoa, Sri Lanka, Taiwan, Thailand, Vietnam, Australia (Tixier 1979, 1980; Grolle & Piippo 1984; Tan & Engel 1986; Piippo 1990; Zhu & So 2001; McCarthy 2006; Lai *et al.* 2008; Söderström *et al.* 2010; Söderström *et al.* 2011; Chuah-Petiot 2011; Thouvenot *et al.* 2011; Wang *et al.* 2011; Long & Rubasinghe 2014; Bakalin & Van Sinh 2016).

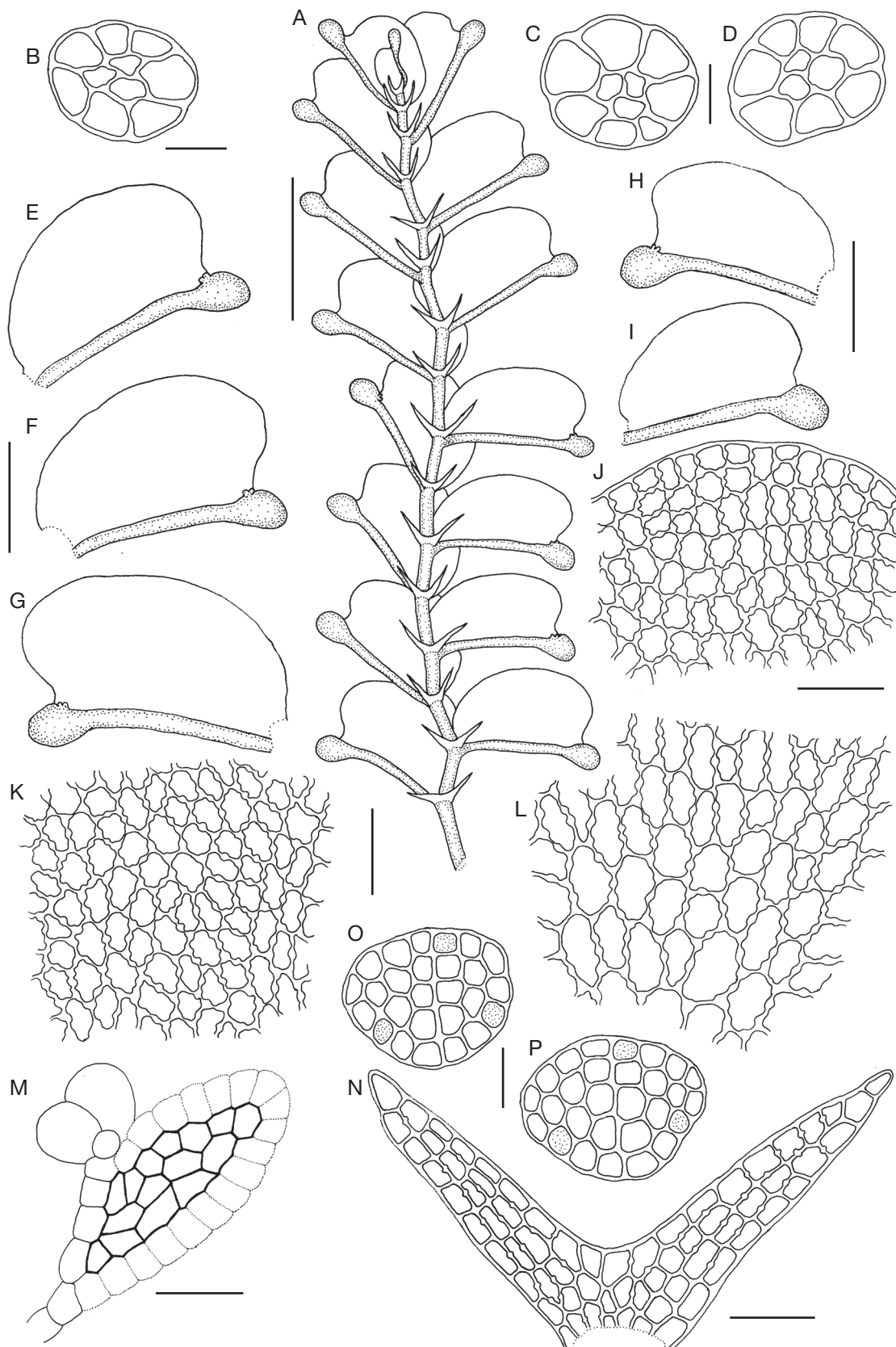


FIG. 1. — *Colura acroloba* (Prantl) Jovet-Ast: **A**, portion of plant in ventral view; **B-D**, cross sections of stem; **E-I**, leaves; **J**, marginal leaf cells towards apex; **K**, median leaf cells; **L**, basal leaf cells; **M**, a valve; **N**, an underleaf; **O**, **P**, gemmae. Scale bars: **A**, 1 mm; **B-D**, **M**, **O**, **P**, 0.03 mm; **E-I**, 0.5 mm; **J-L**, **N**, 0.6 mm.

DESCRIPTION

Plants

Light green when fresh, pale yellowish in herbarium; shoots 5-9 mm long, 1.7-2.2 mm wide including leaves, irregularly branched.

Stem

In cross section suborbicular in outline, 62.5-85.0 µm, 4 cells across the diameter; cortical cells 7, subquadrangular, 17.5-27.5 × 12.5-25.0 µm; medullary cells 3, rectangular-polygonal, 12.5-20.0 × 10.0-15.0 µm; ventral merophyte 1-2 cells wide. Rhizoids numerous, fasciculate at base of underleaves.

Leaves

Contiguous-distant, obliquely-widely spreading; leaf lobes oblong-obovate, 0.8-1.1 mm long, 0.48-0.68 mm wide, dorsal margin arched, ventral margin straight except near apex, margin entire; marginal leaf cells towards apex subquadrate-rectangular, 15.0-32.5 × 12.5-20.0 µm; median leaf cells hexagonal-polygonal, 20.0-35.0 × 15.0-25.0 µm; basal leaf cells slightly elongated, hexagonal-polygonal, 30.0-55.0 × 15.0-35.0 µm; cells with cordate-nodulose trigones, intermediate thickenings 1-2 per cell wall; cuticle smooth; leaf lobules tubular, as long as lobe, slightly wider toward sac, lateral margin usually incurved, sac small inflated at middle, rounded at apex, margin entire, surface smooth, valve elliptical-ligulate, 110.0-127.5 × 75.0-82.5 µm, with 11-15 median cells surrounded by a ring of 20-25 hyaline cells.

Underleaves

Distant, 3-4 times as wide as stem, 0.21-0.26 mm long, 0.21-0.36 mm wide, deeply bilobed, sinus wide, lobes subulate, 7-10 cells long, 3-4 cells wide at base, margin entire.

Gemmae

Present on the leaf lobe, discoid, 72.5-82.5 × 85.0-95.0 µm with 3 adhesive cells.

Androecia and gynoecia

Not seen.

NOTE

Colura acroloba can be easily recognized by its entire dorsal margin of leaf lobe, leaf lobule as long as leaf lobe, sac small rounded at apex and sometimes absent, inflated and with rounded apex, and underleaf lobes 2-4 cells wide at base (Udar & Awasthi 1985).

Colura ari (Steph.) Steph.
(Figs 2A-T; 8B)

Species Hepaticarum 5: 936. (1916).

SPECIMENS EXAMINED. — **India.** Andaman & Nicobar Islands, Port Blair, near ICAR experimental farm, 200 m, 09.XII.1978, *J. Lal. s.n.* (CAL); Assam, Lakhimpur, Dulung Reserve Forest., 16.IX.2011, *N. Odyuo 124472A; 124475E 124476A, 124477A,*

124480E (ASSAM); Dulung Reserve Forest, 17.IX.2011, *N. Odyuo 124479E, 124492E* (ASSAM); Dulung Reserve Forest, 18.IX.2011, *N. Odyuo 124339F, 124340C, 124341A* (ASSAM); Mizoram, Mamit, Dampa Tiger Reserve, Teirei range, Bamboo hut area, 23°40'51.9"N, 92°22'42.9"E, 288 m, 23.XI.2011, *S. K. Singh & Party 123916A, 123917A* (ASSAM); Lawngtlai, Ngengpui WLS, 22°29'49.7"N, 92°46'33.1"E, 138 m, 01.XII.2012, *S. K. Singh & Party 127592B, 127597C, 127601A, 127604A* (ASSAM).

HABITAT. — Follicolous, growing in association with *Caudalejeunea lehmaniana*, *Cololejeunea appressa*, *C. gottschei*, *C. latilobula*, *C. mizutaniana*, *C. subfloccosa*, *Drepanolejeunea foliicola*, *Leptolejeunea balansae*, *L. epiphylla*, *L. foliicola*, *L. maculata*, *Radula acuminata*, *R. tjobodensis*, in relatively less moist places at elevation of 100-300 m a.s.l.

DISTRIBUTION. — India [Andaman & Nicobar, Assam, Mizoram-present study (Singh *et al.* 2016)], Bangladesh, Cambodia, China, Fiji, Indonesia, Malaysia, New Caledonia, Pakistan, Papua New Guinea, Philippines, Samoa, Sri Lanka, Vietnam, Australia (Pócs *et al.* 1967; Grolle & Schultze-Motel 1972; Tixier 1979; Grolle & Piippo 1984; Tan & Engel 1986; Piippo 1990; Banu-Fattah 2001; McCarthy 2006; Söderström *et al.* 2010; Söderström *et al.* 2011; Chuah-Petiot 2011; Thouvenot *et al.* 2011; Long & Rubasinghe 2014; Bakalin & Van Sinh 2016).

DESCRIPTION

Plants

Pale green-yellowish green; shoots 8-18 mm long, 1.8-2.6 mm wide including leaves, irregularly branched.

Stem

In cross section suborbicular in outline, 85.0-125.0 µm, 4 cells across the diameter; cortical cells 7, subquadrate-polygonal, 25.0-50.0 × 20.0-30.0 µm; medullary cells 3, subquadrate-polygonal, 20.0-37.5 × 17.5-27.5 µm; ventral merophyte 2 cells wide.

Rhizoids

Numerous, fasciculate, hyaline, at base of underleaf, rhizoidal disc absent.

Leaves

Imbricate-contiguous, obliquely - widely spreading; lobes obovate, 0.75-1.20 mm long, 0.48-0.66 mm wide, dorsal margin plane towards base, serrate towards apex, denticulations 1-2 cells long, 1-2 cells wide at base, ventral margin nearly straight, smooth; marginal leaf cells towards apex subquadrate-polygonal, 25.0-37.5 × 12.5-27.5 µm; median leaf cells hexagonal-polygonal, 37.5-50.0 × 15.0-30.0 µm; basal leaf cells hexagonal-polygonal, slightly elongated, 37.5-52.5 × 17.5-25.0 µm; cells with cordate-nodulose trigones, intermediate thickenings frequent, 1-3 per cell wall; cuticle smooth; leaf lobules narrowly tubular, as long as leaf lobes, slightly flaring toward sac, lateral margin usually slightly incurved, sac inflated, very small, less than 1/6 as wide as the leaf lobe, acute to rounded at apex, denticulate owing to projecting cells at margin; valve oval-subglobose, 75.0-87.5 × 75.0-85.0 µm, composed of 12-16 median cells surrounded by a ring of 14-15 hyaline cells.

Underleaves

Distant, 2.5-3.5 times as wide as stem, nearly transversely inserted to the stem, 0.19-0.72 mm long, 0.10-0.33 mm

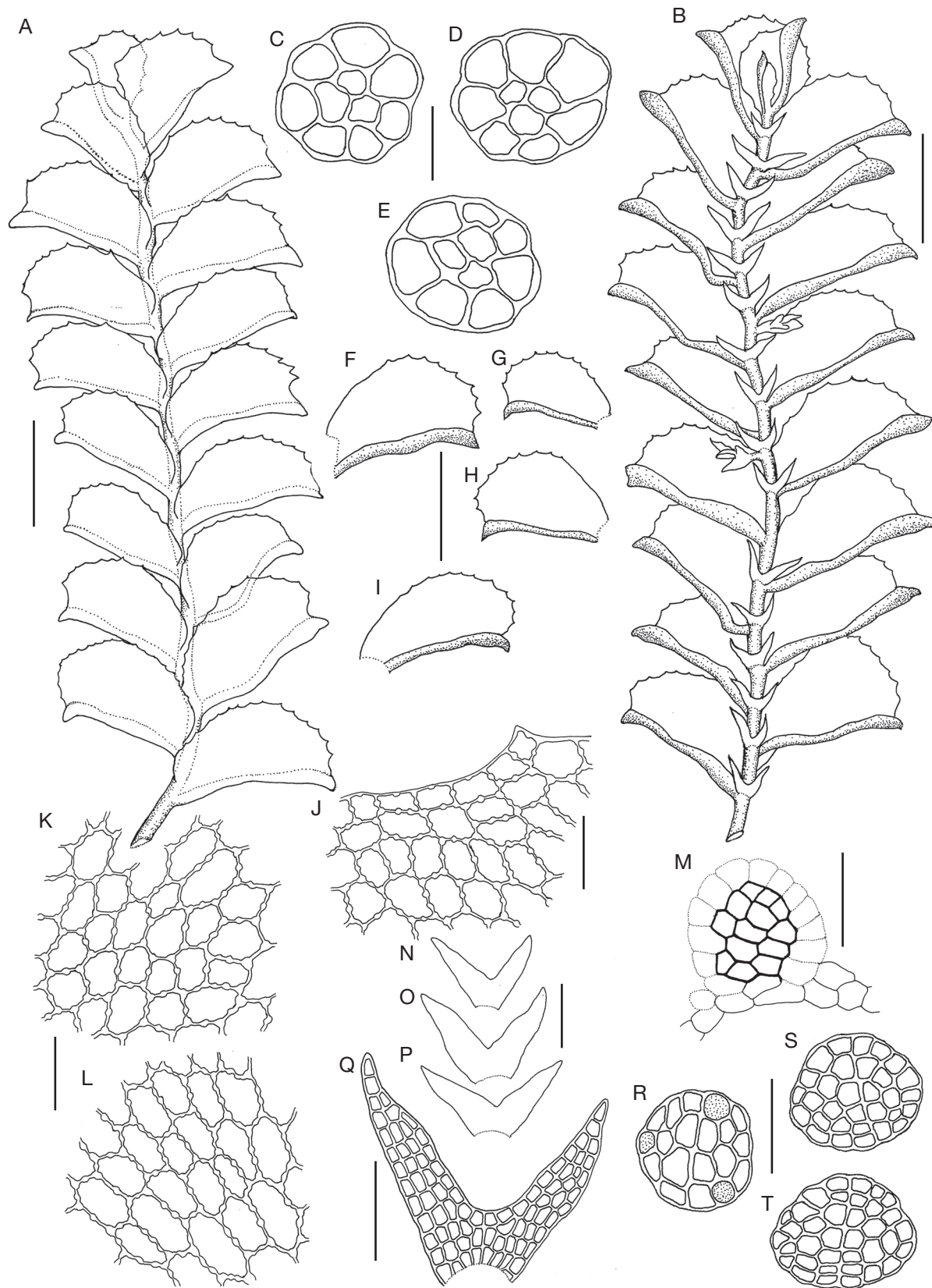


FIG. 2. — *Colura ari* (Steph.) Steph.: **A**, portion of plant in dorsal view; **B**, the same in ventral view; **C-E**, cross sections of stem; **F-I**, leaves; **J**, marginal leaf cells towards apex; **K**, median leaf cells; **L**, basal leaf cells; **M**, a valve; **N-P**, underleaves; **Q**, an underleaf cellular; **R-T**, gemmae. Scale bars: A, B, F-I, 1 mm; C-E, J-M, R-T, 0.05 mm; N-P, 0.5 mm; Q, 0.2 mm.

wide, deeply bilobed, sinus wide, lobes lanceolate, 8-11 cells long, 4-5 cells wide at base, margin entire.

Gemmae

Frequent, spherical-sub spherical, $70.0-77.5 \times 62.5-67.5 \mu\text{m}$ with 3 adhesive cells or sometimes without adhesive cells.

Androecia and gynoecia

Not seen.

NOTE

The species is easily recognized by its serrate dorsal margin of leaf lobe, and the very narrow leaf lobule with its sac slightly turning laterally. It shows similarity with *Colura conica*, but the latter differs in having larger, well developed, straight apiculate sacs (Zhu & So 2001).

Colura calyptrifolia (Hook.) Dumort.

(Fig. 8C)

Recueil d'Observations sur les Jungermanniacées fasc. 1: 12 (1835).

SPECIMENS EXAMINED. — **India**. Kerala, Idukki district, Anaimishola National Park, 2300 m, 08.XI.2017, *Mufeed 7462* (ZGC!).

HABITAT. — Corticolous, growing in association with *Cheilolejeunea xanthocarpa*, *Frullania* sp., *Parmelia* genus of lichens, in moist shady areas of montane wet temperate forest at elevation c. 2300 m a.s.l.

DISTRIBUTION. — India [Kerala (Mufeed *et al.* 2018)], Nepal, Sri Lanka, Taiwan, Chile, Africa, Europe (Söderström *et al.* 2002; Gradstein & da Costa 2003; Zhu & Long 2003; Ros *et al.* 2007; Wigginton 2009; Long & Rubasinghe 2014).

DESCRIPTION

Colura calyptrifolia is characterized by 5-6 mm long and 1.2-1.3 mm wide plants; stem 87-100 μm in diameter, consisting of seven cortical and three medullary cells; leaves, 1.1-1.2 mm long, 0.18-0.25 mm wide, leaf cells thin-walled without trigones and intermediate thickenings; leaf lobules 0.90-1.2 mm long strongly inflated, forming a fusiform sac with a narrow beak towards apex, lobular beak shorter, $\frac{1}{4}$ - $\frac{1}{3}$ as long as the whole leaf, free margin involute, strongly valve at the mouth of the sac, ovate to short-ligulate with hyaline border cells; underleaves deeply bilobed, lobes divergent, 3-4 cells wide at base; and by presence of discoid, 20-22 celled gemmae.

NOTE

The occurrence of *C. calyptrifolia* in Arunachal Pradesh and West Bengal is dubious as there is no trace of specimens at CAL or ASSAM that can substantiate the report and also the detailed description and illustration of the species based on above area materials are lacking.

Colura conica (Sande Lac.) K.I. Goebel

(Figs 3A-S; 8D)

Annales du Jardin Botanique de Buitenzorg 39: 3 (1928).

SPECIMENS EXAMINED. — **India**. Arunachal Pradesh, Tirap, Namdapha National Park, II.1982, *K. P. Singh s.n.* (ASSAM); Mizoram, Lawngtlai, Ngengpui Wildlife Sanctuary, $22^{\circ}29'49.7''\text{N}$, $92^{\circ}46'33.1''\text{E}$, 138 m, 01.II.2012, *S. K. Singh & Party 127633G, 127643A, 127644F* (ASSAM); Tripura, North district, Jampui Hills, Longai river side, $23^{\circ}50'48.9''\text{N}$, $91^{\circ}57'44.7''\text{E}$, 470 m, 26.X.2015, *S. Kumar TSLI-1315A* (ASSAM).

HABITAT. — Foliicolous, growing in association with *Cheilolejeunea ghatensis*, *Cololejeunea subfloccosa*, *Drepanolejeunea foliicola*, *Lejeunea anisophylla*, *L. exilis*, *Leptolejeunea balansae*, *L. epiphylla*, *Radula tjobodensis*, in relatively less moist places at elevation up to 500 m a.s.l.

DISTRIBUTION. — India [Arunachal Pradesh, Mizoram-present study, Tripura (Singh *et al.* 2016)], Bangladesh, Cambodia, China, Fiji, Indonesia, Laos, Vietnam, Malaysia, New Caledonia, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam, Australia (Pócs *et al.* 1967; Tixier 1970, 1979; Grolle & Piippo 1984; Tan & Engel 1986; Zhu & So 2001; Banu-Fattah 2001 as *Colura acutifolia*; McCarthy 2006; Lai *et al.* 2008; Söderström *et al.* 2010; Söderström *et al.* 2011; Chuah-Petiot 2011, also as *Colura acutifolia*; Thouvenot *et al.* 2011; Long & Rubasinghe 2014; Bakalin & Van Sinh 2016).

DESCRIPTION

Plants

Pale green-yellowish green; shoots 5-11 mm long, 1.6-2.2 mm wide including leaves, irregularly branched.

Stem

In cross section suborbicular in outline, 75-107 μm , 4 cells across diameter; cortical cells 7, subquadrangular, (10.0-) 20-45.0 \times (5.0-) 10.0- 37.0 μm ; medullary cells 3, subquadrangular-polygonal, 15.0-25.0 \times 7.5-17.5 μm ; ventral merophyte 1-2 cells wide.

Rhizoids

Numerous, fasciculate, hyaline, at base of underleaf, rhizoidal disc absent.

Leaves

Imbricate-contiguous, obliquely-widely spreading; lobes obovate 0.60-1.05 mm long, 0.36-0.60 mm wide, dorsal margin strongly arched, serrate-serrulate, denticulations 1 cell long and wide at base, ventral margin nearly straight; marginal leaf cells quadrate-subquadrate, 17.5-37.5 \times 12.5-27.5 μm ; median leaf cells hexagonal-polygonal, 30.0-50.0 \times 15.0-22.5 μm ; basal leaf cells slightly larger than median cells, hexagonal-polygonal, 32.5-57.5 \times 10.0-25.0 μm ; cells with cordate-nodulose trigones, intermediate thickenings frequent, 1-3 per cell wall; cuticle smooth; leaf lobules narrowly cylindrical, as long as leaf lobes, slightly flaring toward sac, free lateral margin usually strongly incurved, sac strongly inflated, large, $\frac{1}{3}$ to almost as wide as leaf lobes, usually acute-acuminate or sometimes rounded to subacute at apex, entire or often denticulate owing to projecting cells at margin; valve ovate

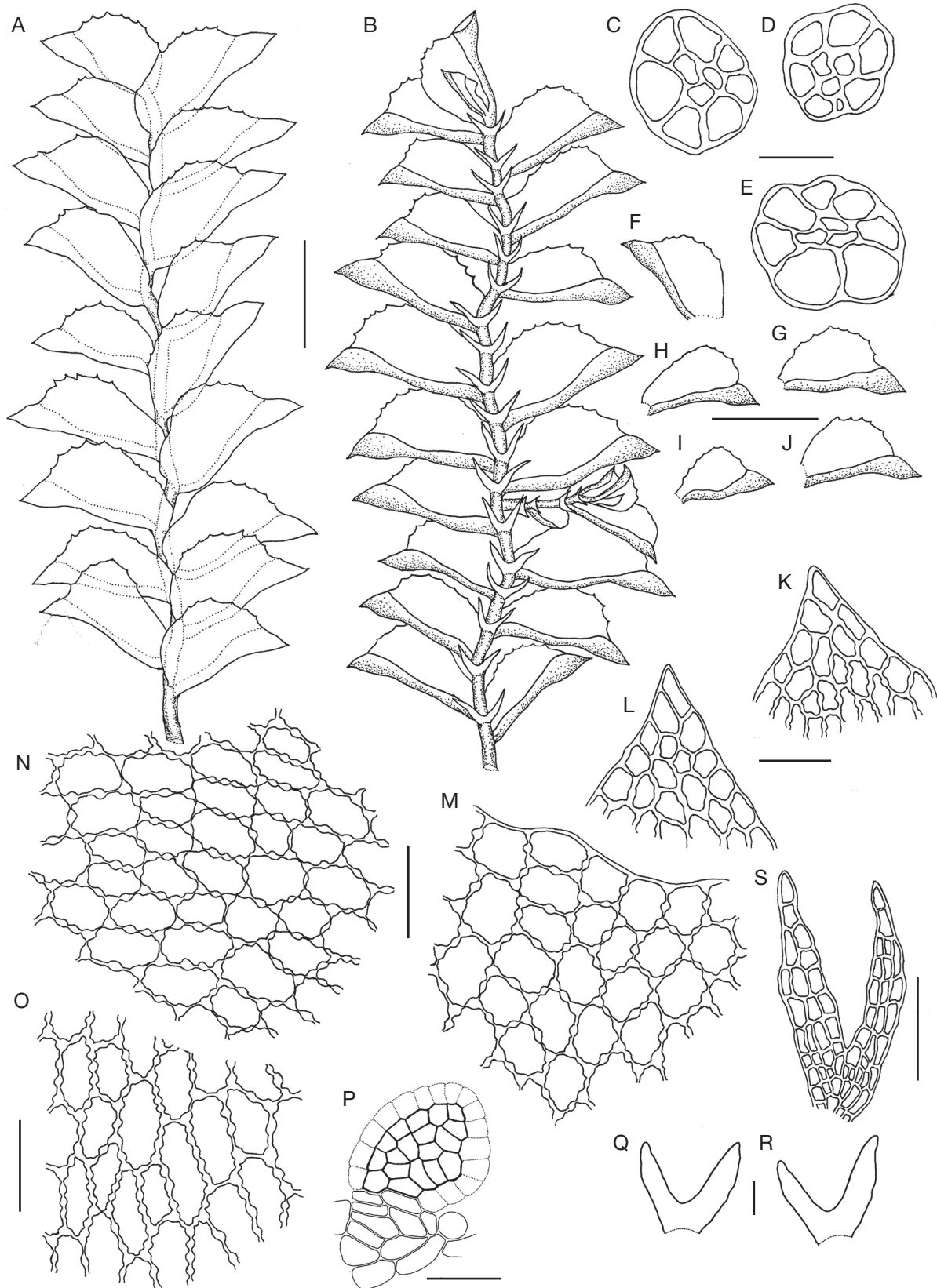


FIG. 3. — *Colura conica* (Sande Lac.) K.I.Goebel: **A**, portion of plant in dorsal view; **B**, the same in ventral view; **C-E**, cross sections of stem; **F-J**, leaves; **K, L**, leaf apices; **M**, marginal leaf cells towards apex; **N**, median leaf cells; **O**, basal leaf cells; **P**, a valve; **Q, R**, underleaves; **S**, an underleaf cellular. Scale bars: A, B, G-J, 1 mm; C-F, K-P, 0,05 mm; Q-S, 0,1 mm.

to short-ligulate, 85.0-105.0 × 80.0-87.5 µm, composed of 14-18 median cells surrounded by a ring of 16 hyaline cells.

Underleaves

Distant, transversely inserted to the stem, 0.19-0.26 mm long, 0.08-0.18 mm wide, 3-4 times as wide as stem, deeply bilobed, sinus U-V-shaped, lobes lanceolate, 7-8 cells long, 3-4 cells wide at base, margin entire.

Gemmae

Absent.

Androecia and gynoecia

Not seen.

NOTE

Colura conica readily distinguishable among the Indian species of the genus by its conical sac which is about 1/3 as wide as leaf lobes.

Colura corynophora (Nees, Lindenb. & Gottsche) Trevis.
(Figs 4A-Z; 8E)

Memorie del Reale Istituto Lombardo di Scienze e Lettere, Serie 3, Classe di Scienze Matematiche e Naturali 4: 402 (1877).

SPECIMENS EXAMINED. — India. Mizoram, Lunglei, Thorang WLS, 23°14'55.6"N, 92°33'48.3"E, 629 m, 30.XI.2011, *S. K. Singh & Party 124232* (ASSAM); Lawngtlai, Ngengpui WLS, 22°29'49.7"N, 92°46'33.1"E, 138 m, 01.XII.2012, *S. K. Singh & Party 127605A* (ASSAM).

HABITAT. — Foliicolous, growing in isolated population or in association with *Caudalejeunea lehmanniana*, *Cololejeunea appressa*, *C. lanciloba*, *Leptolejeunea balansae*, *L. maculata*, in relatively less moist places at elevation of 100-650 m a.s.l.

DISTRIBUTION. — India [Mizoram-present study], Cambodia, China, Fiji, Indonesia, Malaysia, Mariana Is. New Guinea, New Caledonia, Philippines, Sri Lanka, Thailand, Vietnam (Zhu & So 2001; Pócs 2013; Bakalin & Van Sinh 2016).

DESCRIPTION

Plants

Pale yellowish in herbarium; shoots 8-17 mm long, 1.2-1.8 mm wide including leaves, irregularly branched.

Stem

In cross section suborbicular in outline, 55-80 µm, 4 cells across diameter; cortical cells 7, subquadrangular, 17.5-35.0 × 12.5-25.0 µm; medullary cells 3, subquadrangular or sometimes slightly triangular, 12.5-22.5 × 7.5-12.5 µm; ventral merophyte 1 (-2) cells wide.

Rhizoids

Numerous, fasciculate at base of underleaf.

Leaves

Imbricate-contiguous, rarely remote, obliquely-widely spreading; lobes obovate, 0.66-1.02 mm long, 0.39-0.62 mm wide,

margin entire, dorsal margin slightly arched, ventral margin nearly straight; marginal leaf cells towards apex quadrate-subquadrate, 17.5-30.0 × 10.0-20.0 µm; median leaf cells hexagonal-polygonal, 25.0-40.0 × 15.0-25.0 µm; basal leaf cells hexagonal-polygonal, 22.5-37.5 × 10.0-25.0 µm; cells with cordate-nodulose trigones, intermediate thickenings frequent, 1-3 per cell wall; cuticle smooth; leaf lobules usually 3/5-3/4 as long as leaf lobe or sometimes equally long, wide at middle, in most cases reduced, tubular, slightly flaring toward sac, lateral margin usually slightly incurved, sac strongly inflated, occasionally reduced, always rounded at apex, entire at margin; valve elliptical-ligulate, 80.0-100.0 × 42.5-55.0 µm, composed of 12-18 median cells surrounded by a ring of 17-20 hyaline cells.

Underleaves

Distant, nearly transversely inserted to the stem, 0.20-0.24 mm long, 0.18-0.26 mm, deeply bilobed, sinus wide; 2-3 times as wide as stem, lobes linear-lanceolate, 7-8 cells long, 4 cells wide at base, margin entire.

Gemmae

Absent.

Monoicous

Androecia

Terminal on long or very short lateral branches; bracts in 3-5 pairs; bracteoles similar to underleaves but smaller.

Gynoecia

On long branches, terminal; bract lobe oblong, 0.28-0.34 mm long, 0.14-0.25 mm wide, rounded at apex, margin entire; bract lobule linear-oblong, 3/5 as long as the bract lobe, truncate at apex, free margin plane, entire; bracteole similar to underleaf in the size and shape or sometimes highly reduced; perianth obovate, 0.6-0.8 mm long, 0.35-0.40 mm wide, with 3 wing-shaped keels, keels entire at margin, smooth on surface, beak very short, 1 cell long.

Seta

Orbicular in cross section, 62.5-150 µm in diameter with 4 inner and 11 outer cells.

Capsule

Globose, wall bistratose; cells of the outer layer 15.0-27.5 × 7.5-20.0 µm, with sinuate-nodular thickenings; those of the inner layer comparatively smaller, 10.0-22.5 × 7.5-20.0 µm, without or with minute sinuate thickenings.

Spores

25-65 × 10-20 µm, exine finely papillate with usually 1-2 elliptical to ovoid rosettes on its surface.

Elaters

160-210 µm long, 12.5-20.0 µm wide, walls slightly thickened.

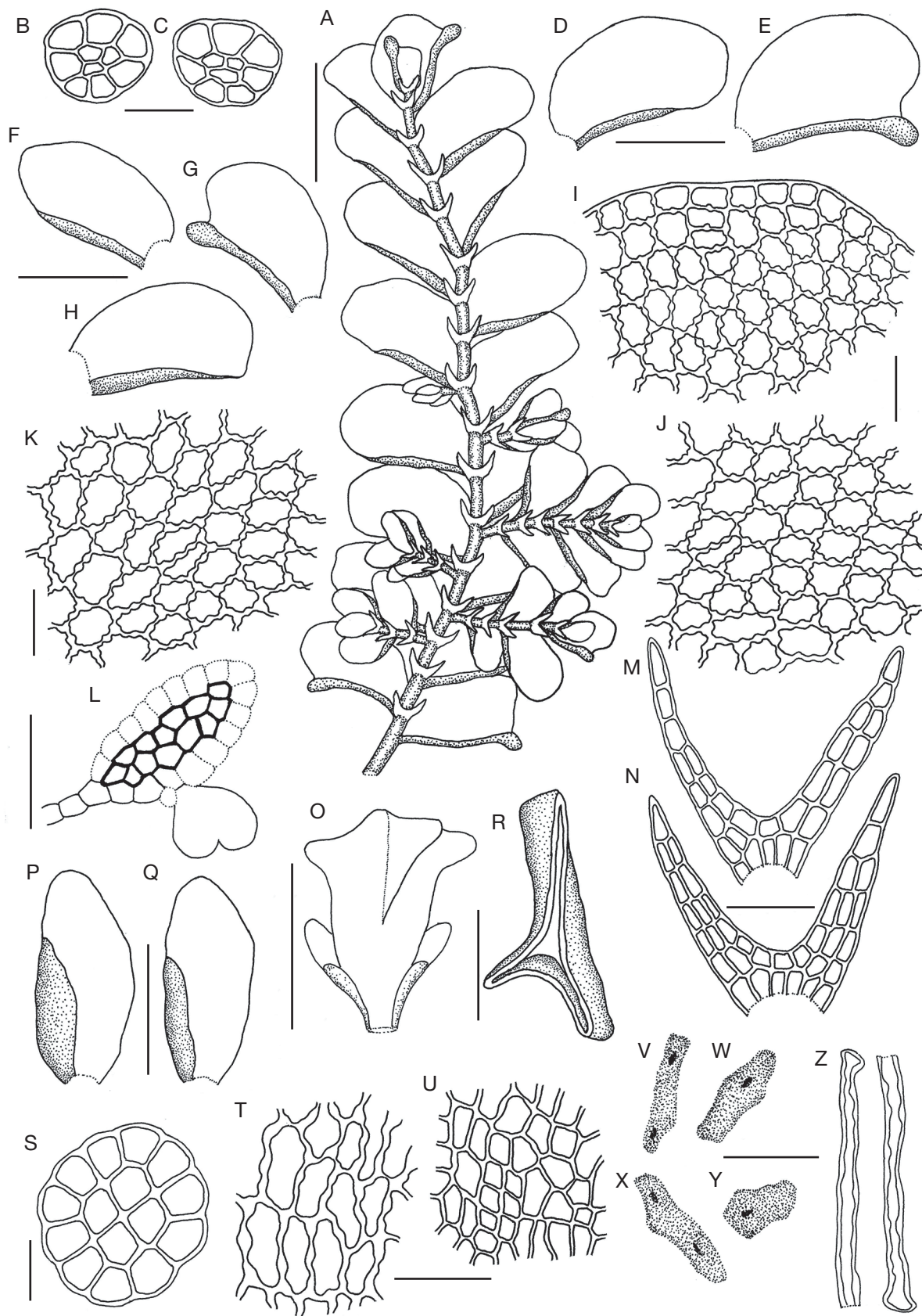


FIG. 4. — *Colura corynophora* (Nees, Lindenb. & Gottsche) Trevis.: **A**, portion of plant in ventral view; **B, C**, cross sections of stem; **D-H**, leaves; **I**, marginal leaf cells towards apex; **J**, median leaf cells; **K**, basal leaf cells; **L**, a valve; **M, N**, underleaves; **O**, a perianth with bracts; **P, Q**, female bracts; **R**, cross section of perianth; **S**, cross section of seta; **T**, cells of outer layer of capsule wall; **U**, cells of inner layer of capsule wall; **V-Y**, spores; **Z**, two elaters. Scale bars: **A**, 1 mm; **B, C, I-K, S-Z**, 0.05 mm; **D-H, O**, 0.5 mm; **M, N**, 0.06 mm; **P-R**, 0.2 mm.

NOTE

Colura corynophora is characterized by its entire dorsal margin of leaf lobe, leaf lobules usually $\frac{3}{5}$ - $\frac{3}{4}$ as long as leaf or sometimes equal to it, the usual absence of a sac, and the underleaf lobes 4 cells wide at base. This species is closely allied to *C. acroloba* in having almost similar leaf lobe margin, leaf cells, valves and underleaves. However, *C. corynophora* can be easily differentiated in the presence of smaller leaf lobules which are usually $\frac{3}{5}$ - $\frac{3}{4}$ as long as leaf lobe and predominantly without terminal sac. The studied plants of Mizoram slightly differ from those from China in plant and underleaf size, but resemble them in all vital taxonomic characters (see Zhu & So 2001). The present report constitutes the first record of *Colura corynophora* from India.

Colura leratii (Steph.) Steph. (Figs 5A-R, 8F)

Species Hepaticarum 5: 939 (1916).

SPECIMEN EXAMINED. — **India**. Mizoram, Lawngtlai, Ngengpui Wildlife Sanctuary, 22°29'49.7"N, 92°46'33.1"E, 138 m, 01.XII.2012, S. K. Singh & Party 127619E (ASSAM).

OTHER SPECIMEN EXAMINED. — *Colura ornata* K.I. Goebel, Indonesia, Java Occ., Res. Batavia, G. Salak, in silvis primigeniis ad decl., c. 1000 m, XII.1893, V. Schiffner 151 (CAL).

HABITAT. — Foliicolous, growing in association with *Cololejeunea nilgiriensis*, *Leptolejeunea elliptica*, *L. epiphylla*, *L. udarii*, *Radula acuminata*, in relatively less moist places at elevation of about 150-700 m a.s.l.

DISTRIBUTION. — India [Karnataka, Mizoram-present study (Singh *et al.* 2016)], Fiji, Indonesia, Malaysia, New Caledonia, Australia (Pócs & Streimann 2006; Söderström *et al.* 2010; Chuah-Petiot 2011; Söderström *et al.* 2011; Thouvenot *et al.* 2011).

DESCRIPTION

Plants

Light green when fresh, pale yellowish in herbarium; shoots 6-9 mm long, 1.8-2.2 mm wide including leaves, irregularly branched.

Stem

In cross section orbicular in outline, 75-102 μm , 4 cells across diameter; cortical cells 7, subquadrate, 17.5-45.0 \times 12.5-37.5 μm ; medullary cells 3, subquadrate-polygonal, 15.0-22.5 \times 10.0-17.5 μm ; ventral merophyte 1-2 cells wide.

Rhizoids

Numerous at the base of underleaves.

Leaves

Imbricate-contiguous, occasionally distant, widely spreading; leaf lobes obovate, 0.52-1.27 mm long, 0.10-0.32 mm wide, margin irregularly dentate-spinose, dorsal margin arched, ventral margin straight, sometime constricted at middle, apex rounded; marginal leaf cells towards apex subquadrate-polygonal, 15.0-35.0 \times 10.0-22.5 μm ; median leaf cells subquadrate

to hexagonal-polygonal, 30.0-57.5 \times 17.5-27.5 μm ; basal leaf cells hexagonal-polygonal, 27.5-60.0 \times 15.0-30.0 μm , cells with cordate-nodulose, intermediate nodular thickenings 1-3 per cell wall; cuticle smooth; leaf lobules narrowly tubular, $\frac{2}{3}$ as long as leaf lobe or slightly longer or sometimes reduced, somewhat flaring toward prolonged conical sac, lateral margin usually slightly incurved, apex acute; valve elliptical, 130.0-145.0 \times 112.5-117.5 μm , with 18-21 median cells surrounded by a ring of 22-24 hyaline cells.

Underleaves

Distant, 3-4 times as wide as the stem, 0.23-0.28 mm long, 0.22-0.35 mm wide, deeply bilobed, sinus wide, lobes linear-lanceolate, 7-10 cells long, 3-8 cells uniseriate towards apex, 2-3 cells wide at base, margin entire.

Gemmae

Absent.

Androecia and gynoecia

Not seen.

NOTE

Colura leratii was reported in India by Asthana and Shukla (2010) from Karnataka, Western Ghats. It is closely allied to *Colura ornata* K.I. Goebel – an Indo-malesian species known from Sri Lanka, Indonesia, Malaysia, Philippines, New Guinea and Indochina (Pócs & Ninh 2012). But, *C. ornata* differs from the *C. leratii* by its lobule which is exceeding the lobe and sac, usually ending into by 4-teethed crest and perianth with three short erect horns (Jovet-Ast 1953). The present species is recorded for the first time from the East Himalayan bryogeographical region of the country.

Colura pluridentata Jovet-Ast (Figs 6A-V; 8G)

Revue bryologique et lichénologique 22: 265 (1953).

SPECIMEN EXAMINED. — **India**. Andaman and Nicobar Islands, Great Nicobar Biosphere Reserve, East-West Road, 12 km from Campbell Bay, c. 176 m, 06°59'53"N, 93°52'56"E, 06.IV.2013, C. Murugan 61507E (CAL).

HABITAT. — Foliicolous, growing in association with *Caudalejeunea recurvistipula*, *Cheilolejeunea serpentina*, *C. trapezia*, *Lejeunea tuberculosa*, *Leptolejeunea epiphylla*, *L. maculata*, *Lopholejeunea subfusca*, *Microlejeunea punctiformis*, in moist and shady condition at elevation c. 200 m a.s.l.

DISTRIBUTION. — India [Andaman and Nicobar Islands (Singh *et al.* 2016)], Fiji, Indonesia, Papua New Guinea, Africa (Seychelles) (Jovet-Ast 1953; Pócs & Eggers 2007; Wigginton 2009; Pócs 2013).

DESCRIPTION

Plants

Light green when fresh, yellowish brown in herbarium; shoot 6-10 mm long, 2.5-3.5 mm wide including leaves; sparsely branched, branching irregular.

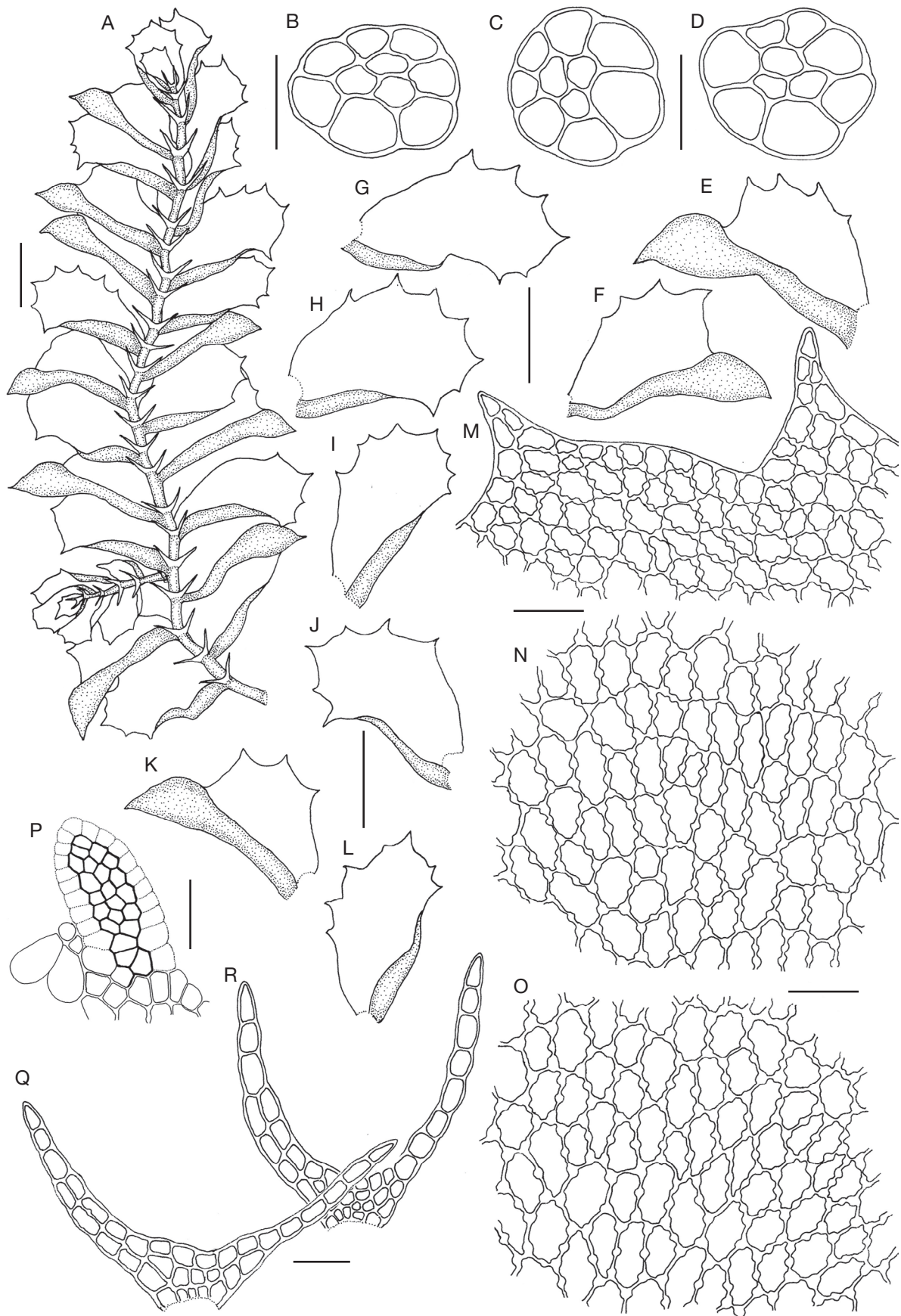


FIG. 5. — *Colura leratii* (Steph.) Steph.: **A**, portion of plant in ventral view; **B-D**, cross sections of stem; **E-L**, leaves; **M**, marginal leaf cells; **N**, median leaf cells; **O**, basal leaf cells; **P**, a valve; **Q, R**, underleaves. Scales bars: **A, E-L**, 0.5 mm; **B-D, M-R**, 0.05 mm.

KEY TO THE SPECIES

1. Valve rounded-ovate, connected to the lobule along a hinge, hence detachable 2
 — Valve more elongated, not detachable, fused directly to the lobule, not detachable 6
2. Lobule sac prolonged into a narrow cylindrical beak; lobe almost as wide as lobule; valve with 2 triangular basal cells, hinge composed of 2 cells 3
 — Lobule broadens towards apex; lobe much broader than the lobule; valve with 1 or 2 rectangular basal cells, hinge composed of 3 cells 4
3. Leaves remotely arranged, lobular beak $\frac{1}{2}$ of leaf length 8. *C. tenuicornis* (A. Evans) Steph.
 — Leaves closely arranged, lobular beak $\frac{1}{3}$ - $\frac{1}{4}$ of leaf length 3. *C. calyptrifolia* (Hook.) Dumort.
4. Lobule sac apex is obtuse or truncate; underleaf lobes usually 8-10 cells wide at their base 7. *C. pluridentata* Jovet-Ast
 — Lobule sac apex acute or apiculate; underleaf lobes usually 2-5 cells wide at their base 5
5. Lobule sac small, less than $\frac{1}{6}$ as wide as the leaf lobe, apex slightly turned outwards and tipped by a triangular point consisting of 1-2 cells 2. *C. ari* (Steph.) Steph.
 — Lobule sac larger, up to $\frac{1}{3}$ as wide as the leaf lobe, apex tipped by a triangular point consisting of 3-8 cells 4. *C. conica* (Sande Lac.) K.I. Goebel
6. Lobe with irregular teeth on the margin; lobule often tipped by a bidentate cren 6. *C. leratii* (Steph.) Steph.
 — Lobe with entire margin; lobule not tipped by a bidentate crest 7
7. Leaves usually with equally well developed, club-shaped lobules ending in an inflated sac 1. *C. acroloba* Jovet-Ast
 — Leaves usually with reduced lobule, ending well below the rounded leaf lobe apex or sometimes a few lobules with club-shaped lobules ending into an inflated sac 5. *C. corynophora*

Stem

Orbicular in outline in cross section, 105-130 μm , 4 cells across diameter; cortical cells 7, rectangular-polygonal, 22.5-45.0 \times 200-37.5 μm , thin-walled; medullary cells 3, polygonal, 20.5-32.5 \times 20.0-30.0 μm , thin-walled; ventral merophyte 2 cells wide.

Rhizoids

Numerous, fasciculate at base of underleaves.

Leaves

Loosely imbricate, obliquely spreading, leaf lobe ovate-lanceolate, 1.4-2.1 mm long, 0.62-0.95 mm wide, dorsal margin arched, proximal $\frac{1}{3}$ entire, distal $\frac{2}{3}$ dentate; teeth (1-) 2-3 (-4) cells long, 1-2 (-3) cells wide at base; ventral margin slightly arched; marginal leaf cells towards apex rectangular-polygonal, 17.5-30.0 \times 15.0-30.0 μm ; median leaf cells hexagonal-polygonal, 37.5-55.0 \times 17.5-27.5 μm ; basal leaf cells slightly elongated, polygonal, 50.0-70.0 \times 20.0-27.5 μm ; cells thin-walled with large, cordate-nodulose trigones, intermediate thickenings subnodulose, 1-2 per cell wall; cuticle smooth; leaf lobule inflated, 1.6-2.0 mm long, 0.24-0.30 mm wide, cylindrical at base, widest at middle, terminating into a strongly inflated, cylindrical to lanceolate sac; sac 0.62-0.75 mm long, widest at base, narrowing towards

apex, apex rounded to obtuse, margin entire; valve ovoid, 105-175 \times 90-130 μm with 18-20 median cells and 2 median basal cells surrounded by a ring of 14-18 hyaline cells.

Underleaves

Distant, 3-4 times as wide as stem, 0.42-0.80 \times 0.48-0.90 mm, deeply bilobed, sinus wide, lobes divergent, lanceolate, 12-15 long, 8-10 cells wide at base, 1-2 cells uniseriate at apex, margin entire.

Gemmae

Clustered at the apex of leaf lobule, discoid, 17-24-celled, 40-80 μm in diameter.

Androecia and gynoecia

Not seen.

NOTE

Colura pluridentata is readily distinguishable among the Indian species of the genus in having underleaf lobes 8-10 cells wide at base. In having denticulate to dentate leaf lobe margins, it is somewhat similar to *C. ari* and *C. conica*. But, both the species are distinct from *C. pluridentata* in having leaf lobule sacs ending into acute-apiculate apices (see also Jovet-Ast 1953; Lal 1980, 2003; Pócs & Eggers 2007; Dey & Singh 2016).

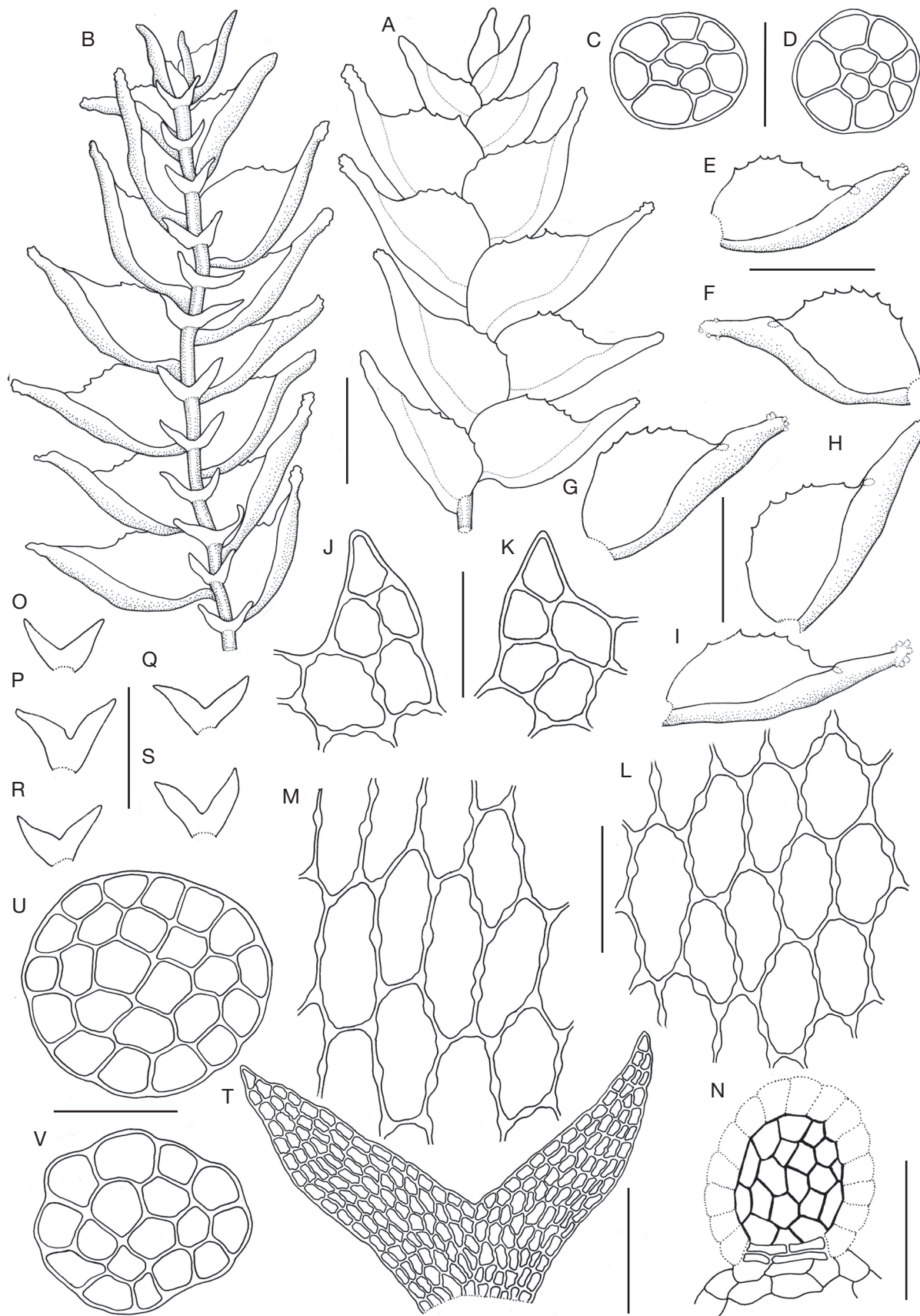


FIG. 6. — *Colura pluridentata* Jovet-Ast: **A**, portion of plant in dorsal view; **B**, the same in ventral view; **C, D**, cross sections of stem; **E-I**, leaves; **J, K**, marginal leaf cells; **L**, median leaf cells; **M**, basal leaf cells; **N**, a valve; **O-S**, underleaves; **T**, an underleaf cellular; **U, V**, gemmae. Scale bars: **A, B, E-I, O-S**, 1 mm; **C, D, N**, 0.1 mm; **J-M, U, V**, 0.05 mm; **T**, 0.2 mm.

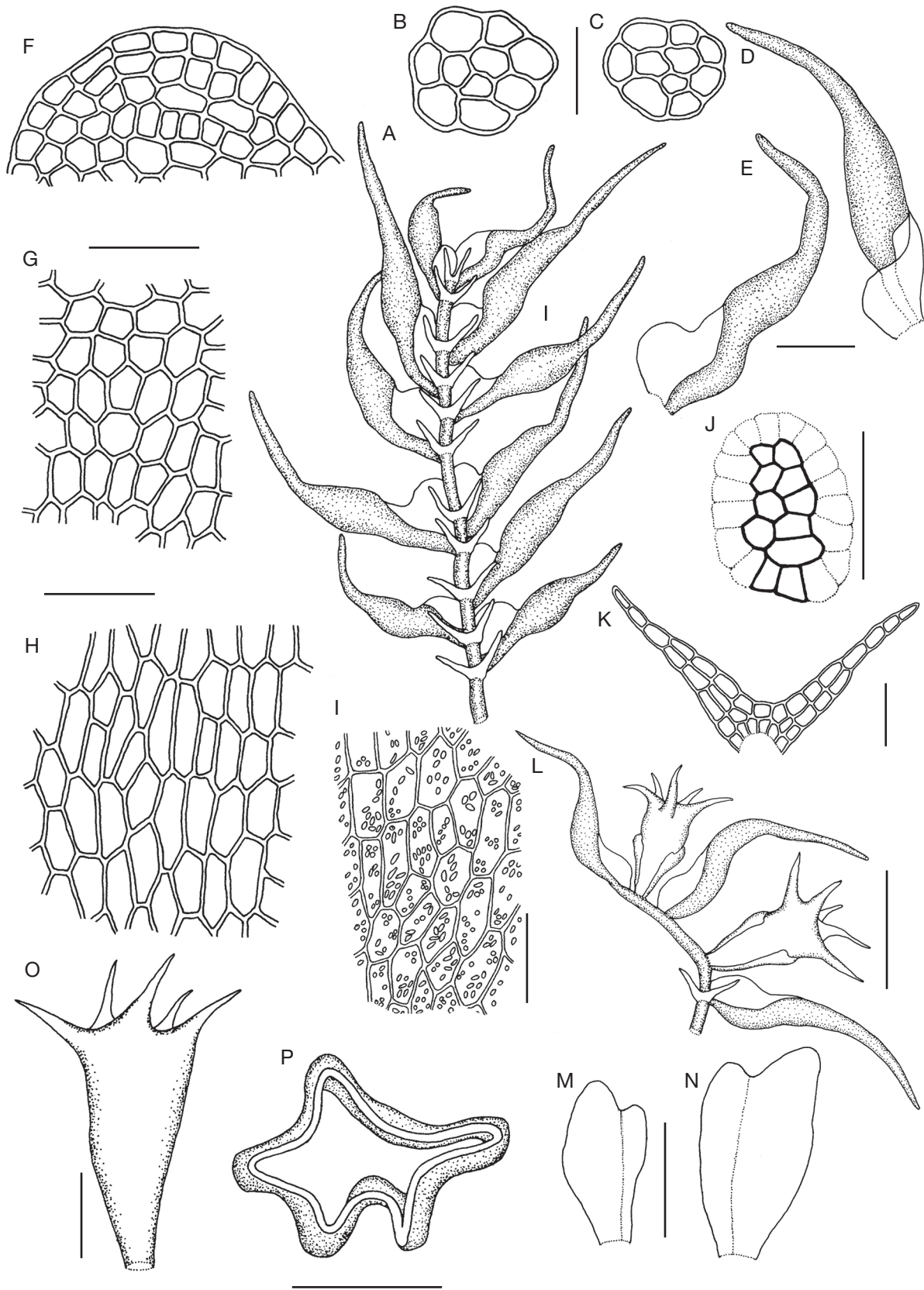


FIG. 7. — *Colura tenuicornis* (A. Evans) Steph.: A, portion of plant in ventral view; B, C, cross sections of stem; D, E, leaves; F, marginal leaf cells; G, median leaf cells; H, basal leaf cells; I, mid basal cells showing oil-bodies; J, a valve; K, an underleaf cellular; L, a portion of plant with gynoecial branches in ventral view; M, N, female bracts; O, a perianth; P, cross section of perianth. Scale bars: A, D-H, M-O, 0.2 mm; B, C, J-L, 0.05 mm; I, 0.03 mm.

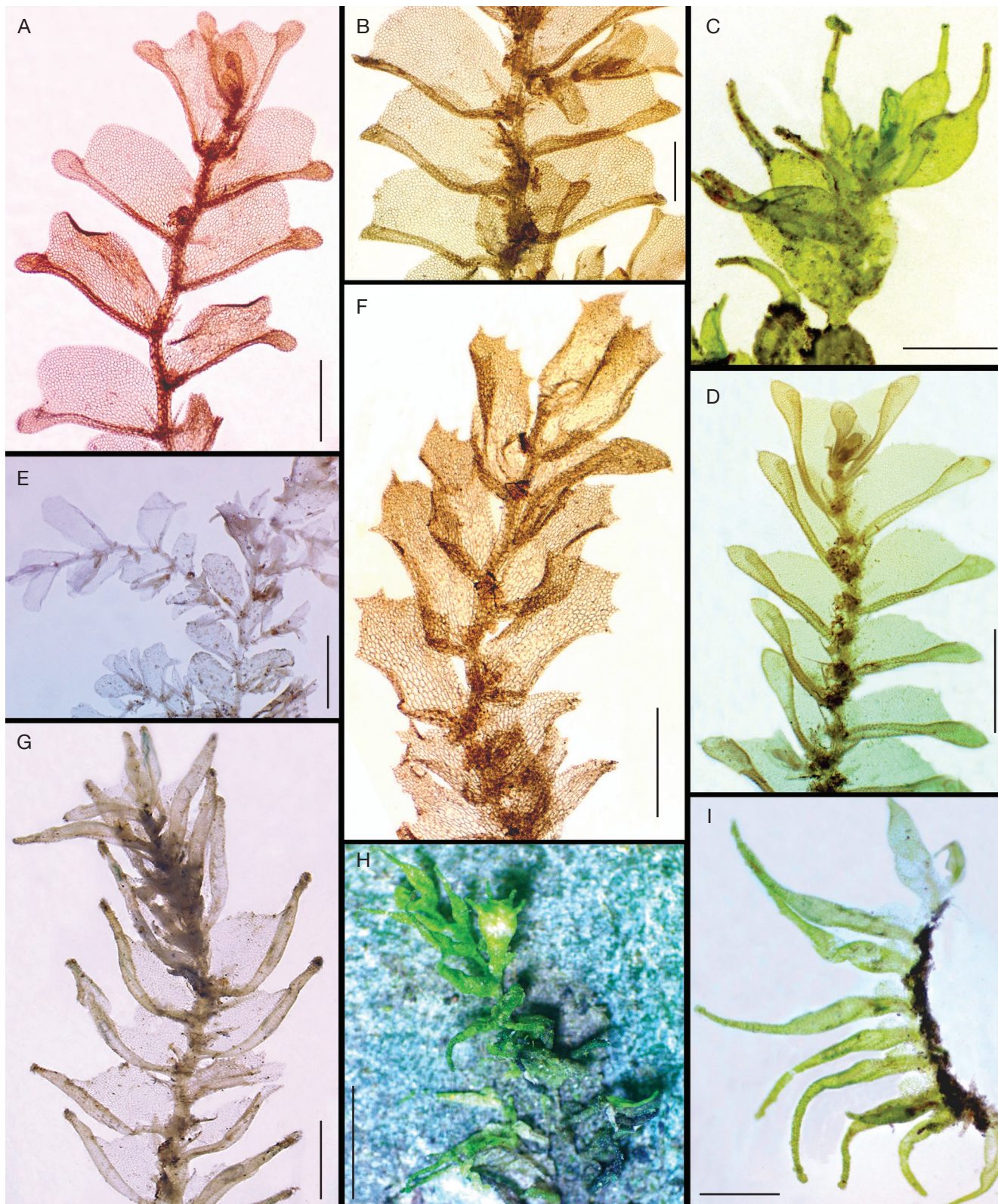


FIG. 8. — **A**, *Colura acroloba* (Mont. ex Steph.) Jovet-Ast; **B**, *Colura ari* (Steph.) Steph.; **C**, *Colura calyptrifolia* (Hook.) Dumort.; **D**, *Colura conica* (Sande Lac.) K.I.Goebel; **E**, *Colura corynophora* (Nees, Lindenb. & Gottsche) Trevis.; **F**, *Colura leratii* (Steph.) Steph.; **G**, *Colura pluridentata* Jovet-Ast; **H**, **I**, *Colura tenuicornis* (A.Evans) Steph. Scale bars: A, B, F, G, I, 0.5 mm; C, 0.6 mm; D, E, H; 1 mm.

Colura tenuicornis (A. Evans) Steph.

(Figs 7A-P; 8H, I)

Species Hepaticarum 5: 942 (1916).

SPECIMENS EXAMINED. — **India.** Arunachal Pradesh, Dibang Valley district, on way to Dessali from Hunli, *c.* 1150 m, 15.01.1984, *D. K. Singh 675C/1984* (ASSAM); Lower Dibang Valley district, Chekhopani, *c.* 2000 m, 17.XI.2000, *D.K. Singh 98169B* (BSD); Meghalaya, East Khasi Hills, Elephant falls, 25°32'12.8"N, 91°49'21.03"E, 1769 m, 02.V.2016, *Shasi Kumar TSLI - 2105* & 23.VII.2016, *TSLI - 2193, 2194* (ASSAM); near Mawkajem, 25°25'23"N, 91°51'47"E, 1715 m, 25.XI.2017, *S. K. Singh & Party TSLI - 3796* (ASSAM); Sikkim, North district, Thulung, 27°38'13.3"N, 88°26'29"E, *c.* 2449 m, 03.IV.2013, *D. Singh 60598B* (CAL); East district, Pangthang, *c.* 1988 m, 18.IX.2007, *D. Singh 40967* (CAL); ½ km before Bojogari falls on way from Burtak to Pangthang, *c.* 1850 m, 28.VII.2008, *B. S. Kholia 41103C* (CAL); West district, between Hilley and Barsey, *c.* 2784 m, 26.V.2008, *K. Das 41091B* (CAL); Hilley, *c.* 2766 m, 28.V.2008, *K. Das 41096C* (CAL), 08.III.2010, *D. Singh & S. Majumdar 47562A* (CAL); 12th mile from Hilley towards Okhrey, *c.* 2700 m, 12.III.2010, *D. Singh & S. Majumdar 47740B, 47746C* (CAL); South district, Maenam Wildlife Sanctuary, 27°18'42.5"N, 088°21'54.5"E, *c.* 2192 m, 01.VI.2011, *D. Singh 51720A, 51745B*; West Bengal, Darjeeling district, Takdah, *c.* 1650 m, 17.I.2005, *D. Singh & M. Dey 36218* (CAL).

HABITAT. — Follicolous, growing in association with *Cololejeunea latilobula*, *C. longifolia*, *C. pseudofloccosa*, *C. truncatifolia*, *Drepanolejeunea erecta*, *D. fleischeri*, *D. longii*, *Lejeunea anisophylla*, *L. discreta*, *L. flava*, *L. wallichiana*, *Leptolejeunea balansae*, *L. elliptica*, *Microlejeunea punctiformis*, in moist and shady places at elevation of 1200-2800 m a.s.l.

DISTRIBUTION. — India [Arunachal Pradesh, Meghalaya-present study, Sikkim, West Bengal (Singh *et al.* 2016)], Bhutan, Cambodia, China, Comoro Archipelago, Fiji, Galapagos, Hawaii, Indonesia, Japan, Malaysia, Nepal, Papua New Guinea, Sri Lanka, Taiwan, Vietnam, Africa, South America (Tixier 1979; Yano 1984; Grolle & Piippo 1984; Piippo 1990; Pócs 1993; Zhu & Long 2003; Staples & Imada 2006; Yamada & Iwatsuki 2006; Pradhan & Joshi 2009; Wigginton 2009; Söderström *et al.* 2010; Söderström *et al.* 2011; Gradstein & Ziemmeck 2011; Chuah-Petiot 2011; Wang *et al.* 2011; Long & Rubasinghe 2014; Bakalin & Van Sinh 2016).

DESCRIPTION

Plants

Green when fresh, pale yellowish green in herbarium; shoots 2-6 mm long, (1.0-) 1.8-2.4 mm wide including leaves; branching irregular.

Stem

In cross section suborbicular in outline, 52.5-82.5 × 52.5-75.0 µm, 4 cells across diameter; cortical cells 7, subquadrate-rectangular or polygonal, 17.5-32.5 × 10.0-22.5 µm, thin-walled; medullary cells 3, polygonal, 15.0-25.0 × 10.0-17.5 µm, cells thin-walled. Ventral merophytes 1-2 cells wide.

Leaves

Contiguous-remote, obliquely-widely spreading, leaf lobes lanceolate, 0.25-0.45 mm long, 0.12-0.20 mm wide, margin entire, dorsal margin slightly arched, ventral margin nearly straight-slightly arched; marginal leaf cells towards apex rectangular-polygonal or subquadrate, 12.5-20.0 × 7.5-12.5 µm; median leaf cells pentagonal-hexagonal, 15.0-

27.5 × 10.0-17.5 µm; basal leaf cells elongated pentagonal - hexagonal or rectangular, 25.0-45.0 × 10.0-17.5 µm; cells thin-walled without trigones and intermediate thickenings; cuticle smooth; oil-bodies 6-14 per leaf cell, spherical, 2.0-3.5 µm in diameter, or elliptical, 5.0-7.2 × 2.5-4.0 µm; leaf lobules inflated, 2-3 times as long as the lobe, widest at middle, 0.75-1.25 mm long, 0.13-0.17 mm wide, sac cylindrical-lanceolate forming a long tubular beak towards apex, beak *c.* ½ as long as leaf lobule, margin entire; valve elliptical-ovoid, 87.5-92.5 × 65.0-72.5 µm, composed of 11-14 median cells surrounded by a ring of 15-16 hyaline cells, hinge distinct.

Underleaves

Remote, (2.5-) 3-4 times as wide as the stem, 0.16-0.19 mm long, 0.13-0.25 mm wide, deeply bilobed, sinus wide, lobes divergent, linear-lanceolate, 6-8 cells long, 2-3 cells wide at base, apex subacute, margin entire. According to Jovet-Ast (1953) monoicous. Androecial branches on Indian plants not seen.

Androecia and gynoecia

Androecial branches on Indian plants not seen; gynoecia on short or long branches, with one subfloral innovation; bract lobe narrowly oblong, (0.25-) 0.37-0.51 mm long, 0.10-0.16 mm wide; bract lobule, (0.2-) 0.31-0.45 mm long, (0.04-) 0.07-0.10 mm wide; bracteoles not seen. Perianth obovate, 0.62-0.81 mm long, 0.22-0.27 mm wide, mouth with five large horn-like keels (two lateral, two ventral and one dorsal); keels ½ as long as the perianth, subcylindrical, apices sharply acute, margin entire, surface smooth. According to Jovet-Ast (1953) monoicous.

Mature sporophytes

Not seen.

NOTE

C. tenuicornis is characterized by its contiguous-remote leaves with lanceolate leaf lobe; thin-walled leaf cells devoid of trigones and intermediate thickenings; cylindrical-lanceolate lobule sac forming a long tubular beak towards apex, *c.* ½ as long as the whole leaf, and perianth with five large horn-like keels (Zhu & So 2001; Dey & Singh 2012). The species is closely allied to *C. calyptrifolia*, but the latter differs by its shorter lobular beak (¼-½ as long as the whole leaf) and perianth with five short spreading horns (Porley 1997; Yang *et al.* 2013; Mufeed *et al.* 2018).

Acknowledgements

We thank the Director, Botanical Survey of India, Kolkata for encouragement; Dr D. K. Singh, Scientist G (Rtd.), BSI Kolkata and two anonymous reviewers for their valuable suggestions towards improvement of the manuscript; forest officials of Mizoram, Meghalaya, Sikkim and Andaman & Nicobar Islands for rendering help during field work. We are also thankful to Dr Manju C. Nair, Asstt. Prof., The zamorin Guruvayurappan College, Kerala for provid-

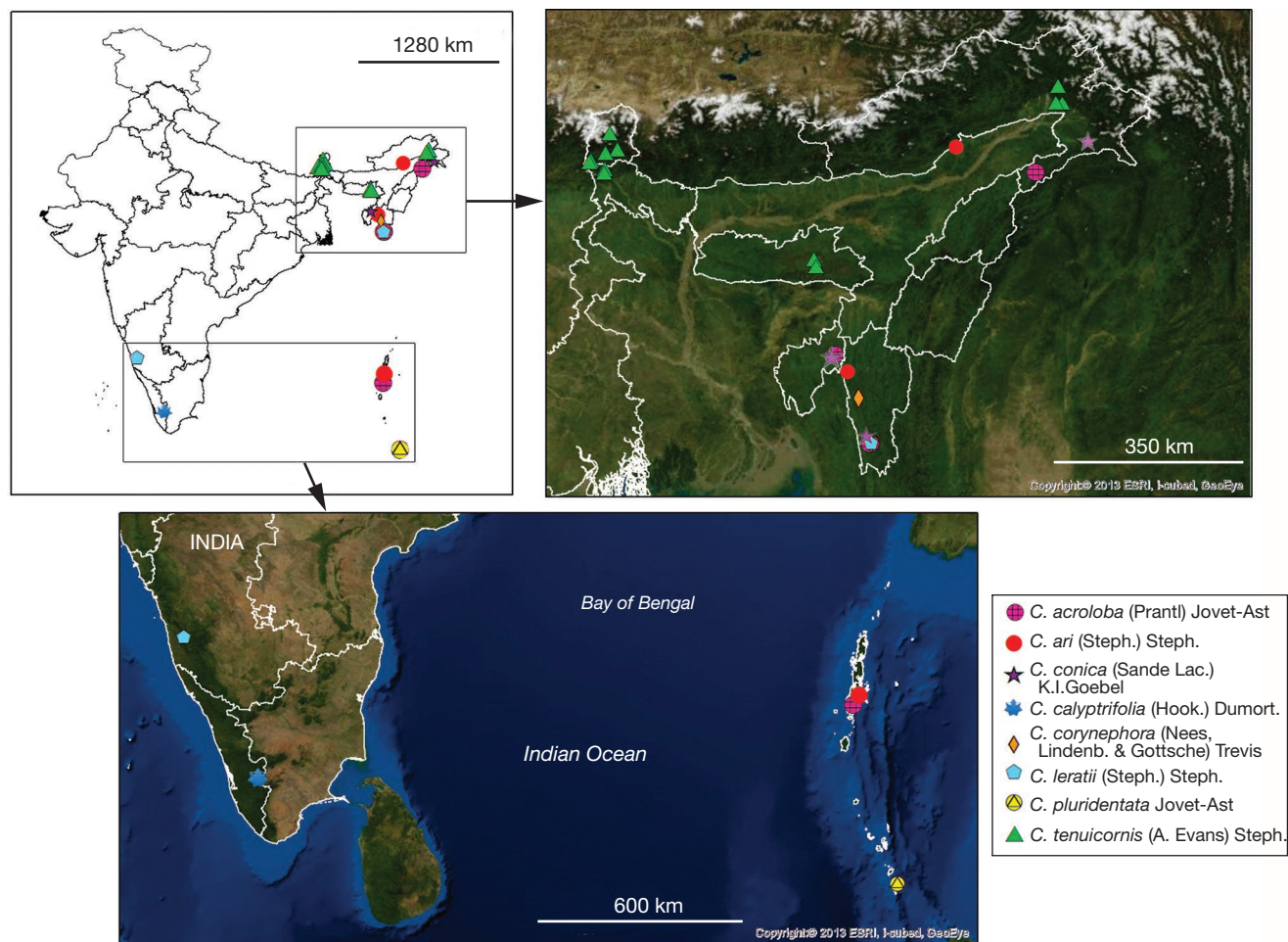


FIG. 9. — Distribution of the species of genus *Colura* (Dumort.) Dumort. in India.

ing the specimens of *Colura calyptrifolia* for study and its photographs; Ms. Natasha Shrivastava, BSI, Howrah for the help with distribution map. Shashi Kumar (SPF) is also grateful to director, BSI, for financial assistance under 'Flora of India' project.

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Submitted on 18 August 2018;
accepted on 1 July 2020;
published on 24 July 2020.