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ABSTRACT
Koponobryum papillosum Printarakul & Chantanaorr., sp. nov., is described as a second species of the genus found in Chiang Mai and Lamphun Provinces, northern Thailand. It is distinguished from *K. bengalense* (Gangulee) Arts by autoicous plants, papillose spores and axillary hairs consisting of one short basal cell and 1-4(5) longer upper cells. A taxonomic description, illustrations and SEM micrographs are presented.

KEY WORDS
Bryophyte diversity, *Koponobryum bengalense*, pottiaceous moss, northern Thailand, new species.

RÉSUMÉ
Koponobryum papillosum *Printarakul & Chantanaorr., sp. nov. une nouvelle espèce de mousse du nord de la Thaïlande.*
Koponobryum papillosum Printarakul & Chantanaorr., sp. nov. est décrit comme une deuxième espèce du genre trouvée dans les provinces de Chiang Mai et Lamphun, dans le nord de la Thaïlande. Elle se distingue de *K. bengalense* (Gangulee) Arts par des plantes auto-portantes, des spores papillaires et des poils axillaires constitués d'une cellule basale courte et de 1-4(5) cellules supérieures plus longues. Une description taxonomique, des illustrations et des micrographies MEB sont présentées.

MOTS CLÉS
Diversité des bryophytes, *Koponobryum bengalense*, mousse pottiacée, Thaïlande du nord, espèce nouvelle.

INTRODUCTION

The genus *Koponobryum* Arts was first established by Arts (2001) with a single species, *K. bengalense* (Gangulee) Arts, a species endemic to India. The genus was segregated from *Splachnobryum* Hal.Müll. by the following combination of characters: bordered leaves, the acute leaf apex, the excurrent costa, and the upper lamina cells bearing one central papilla (Arts 2001). Although *Koponobryum* was originally placed in the Splachnobryaceae (Arts 2001), further molecular studies show that the Splachnobryaceae nested in the Pottiaceae (e.g., Werner *et al.* 2004; Frey & Stech 2009; Cox *et al.* 2010).

During the bryological surveys in Chiang Mai and Lamphun Provinces, northern Thailand, some interesting specimens of pottiaceous mosses were collected. They have lanceolate to oblong-lanceolate leaves with acute to acuminate apex and decurrent base, upper lamina cells bearing one central papilla, leaf margins bordered by 1-3 rows of elongate cells, costa excurrent and costa in cross section with one stereid band. This combination of characters implies the genus *Koponobryum*, but the collection did not match *K. bengalense*. It is therefore described here as a species new to science.

MATERIAL AND METHODS

This study is based on recent collections from Thailand. Voucher specimens of the new species are deposited in BKF, CMUB, and PSU herbaria. Morphological and anatomical characters were studied using stereo and compound microscopes. The distinctive characters of the species were illustrated. Mature spores and peristome were and examined with JEOL JSM-5910 LV scanning electron microscope. In addition, detailed descriptions, illustrations, and notes on species of *Koponobryum* are provided.

TAXONOMIC TREATMENT

Family Splachnobryaceae A.K. Kop.
Genus *Koponobryum* Arts

Koponobryum papillosum
Printarakul & Chantanaorr., sp. nov.
(Figs 1-3)

Diagnosis. — Similar to *K. bengalense* (Gangulee) Arts, but differing in autoicous plants, papillose spores, and axillary hairs consisting of one short basal cell and 1-4(5) longer upper cells.

Type. — **Thailand**. Chiang Mai Province: Mae Rim District, Doi Suthep-Pui National Park, Mae Sa Falls, 18°54'25.7"N, 98°53'46.6"E, *c.* 420 m elev., 19.VII.2020, *N. Printarakul & K. Adulkittichai 19072020_1* (holo-, CMUB!; iso-, BKF!, PSU!).

Additional specimens examined. —**Thailand**. Chiang Mai Province: Mae Rim District, Doi Suthep-Pui National Park, Mae Sa Falls, *c.* 420 m elev., on soil under granitic rock, 18°54'25.7"N, 98°53'46.60"E, 4.X.2013, *N. Printarakul 6444* (CMUB); Chiang Dao District, Doi Chang Dao Wildlife Sanctuary, Huay Sob On forest protection unit, *c.* 710 m elev., on soil under calcareous rocks, 19°21'33.7"N, 98°43'07.5"E, 19.VIII.2017, *N. Printarakul 7280* (CMUB, PSU). Lamphun Province: Sri Bua Ban District, the Hariphuchai Education Centre of Chiang Mai University, *c.* 500 m elev., on soil under calcareous-sandstones, 18°32'17.33"N, 99°07'28.10"E, 22.VIII.2020, *N. Printarakul, A. Jampeetong & U. ongkawong 22082020_15* (CMUB).

Etymology. — The specific epithet "*papillosum*" refers to the papillose spores.

Habitat and distribution. — *Koponobryum papillosum* Printarakul & Chantanaorr., sp. nov. is currently known only from northern Thailand. It grows on disturbed soils on a degraded calcareous substrate, sandstones and granitic rocks in deciduous, dipterocarp-oak, and also in mixed evergreen-deciduous seasonal forests at elevation of 420-710 m.

Conservation status. — IUCN (2012) category Least concern (LC). Although only three locations were found in Thailand, they are within the well-protected areas. Therefore, this species is not under immediate threat.

Description

Plants
Up to 17 mm high (including sporophytes), pale to light green, forming loose turfs.

Rhizoids
Reddish to pale brown, clustered at stem base.

Stems
Erect, unbranched, dark green to reddish brown, in cross section 8-10 layers of cells across, 120-150 µm in diameter; outer cortical cells somewhat smaller with moderately thick-walled, inner cortical cells larger with thicker walls; central stand consisting of smaller and thin-walled cells.

Axillary hairs
Filiform, uniseriate, 2-5(-6) cells long, the basal cell shortest and yellowish to pale brown, the upper cells distinctly longer and colorless.

Leaves
Contorted when dry, erecto-patent to spreading when moist; lanceolate to oblong-lanceolate, 1.1-1.5 × 0.3-0.4 mm; apex acute to acuminate; base slightly decurrent; margins plane above, slightly revolute below, bordered throughout by 1-3 rows of elongate cells, remotely serrulate to denticulate above the midleaf; costa single, stout, short excurrent, ventral and dorsal surfaces smooth, not prominently bulging; costa cross section at midleaf semicircular to elliptic, with one stereid band; lamina unistratose, orange to red with KOH; upper laminal cells subquadrangular, polygonal to rounded-hexagonal, (20-) 25-30 µm in diameter, with a central papilla on both sides, firm to slightly thick-walled; basal marginal cells elongate rectangular, (35-) 40-80 × 12.5-15 µm wide, thin-walled; basal juxtacostal cells broader, rectangular, (37.5-)50-90 × 25-35 µm, thin-walled.

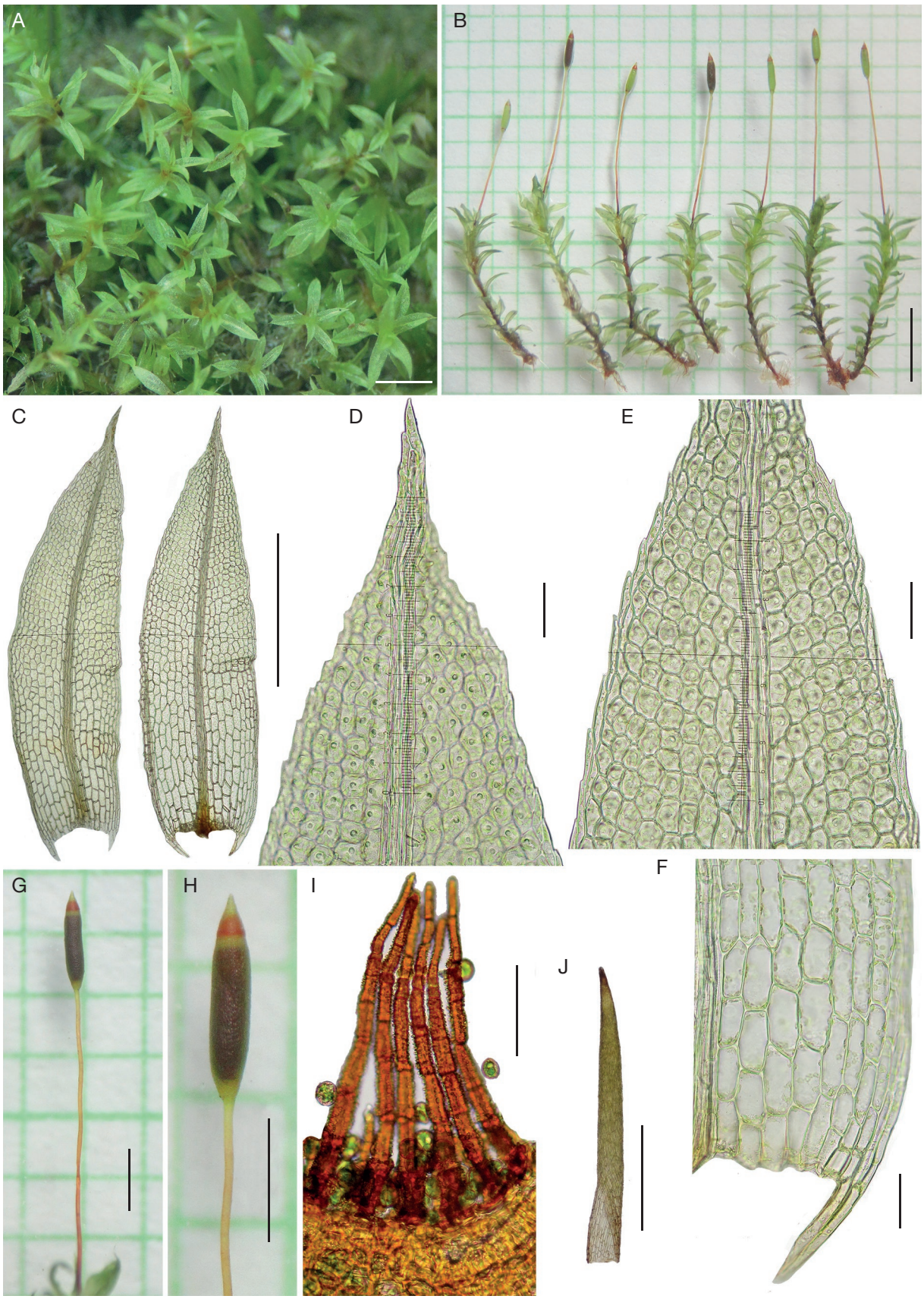

FIG. 1. — *Koponobryum papillosum* Printarakul & Chantanaorr., sp. nov.: **A**, plants in natural habitat; **B**, sporophyte bearing plants; **C**, leaves; **D**, leaf apex; **E**, upper laminal cells and marginal cells; **F**, leaf bases; **G**, sporophyte; **H**, capsule; **I**, peristome and spores; **J**, calyptra. Photos by N. Printarakul. All from *N. Printarakul & K. Adulkittichai 19072020_1* (CMUB). Scales bars: A, G, H, 1 mm; B, 3 mm; C, J, 0.5 mm; D-F, I, 50 µm.

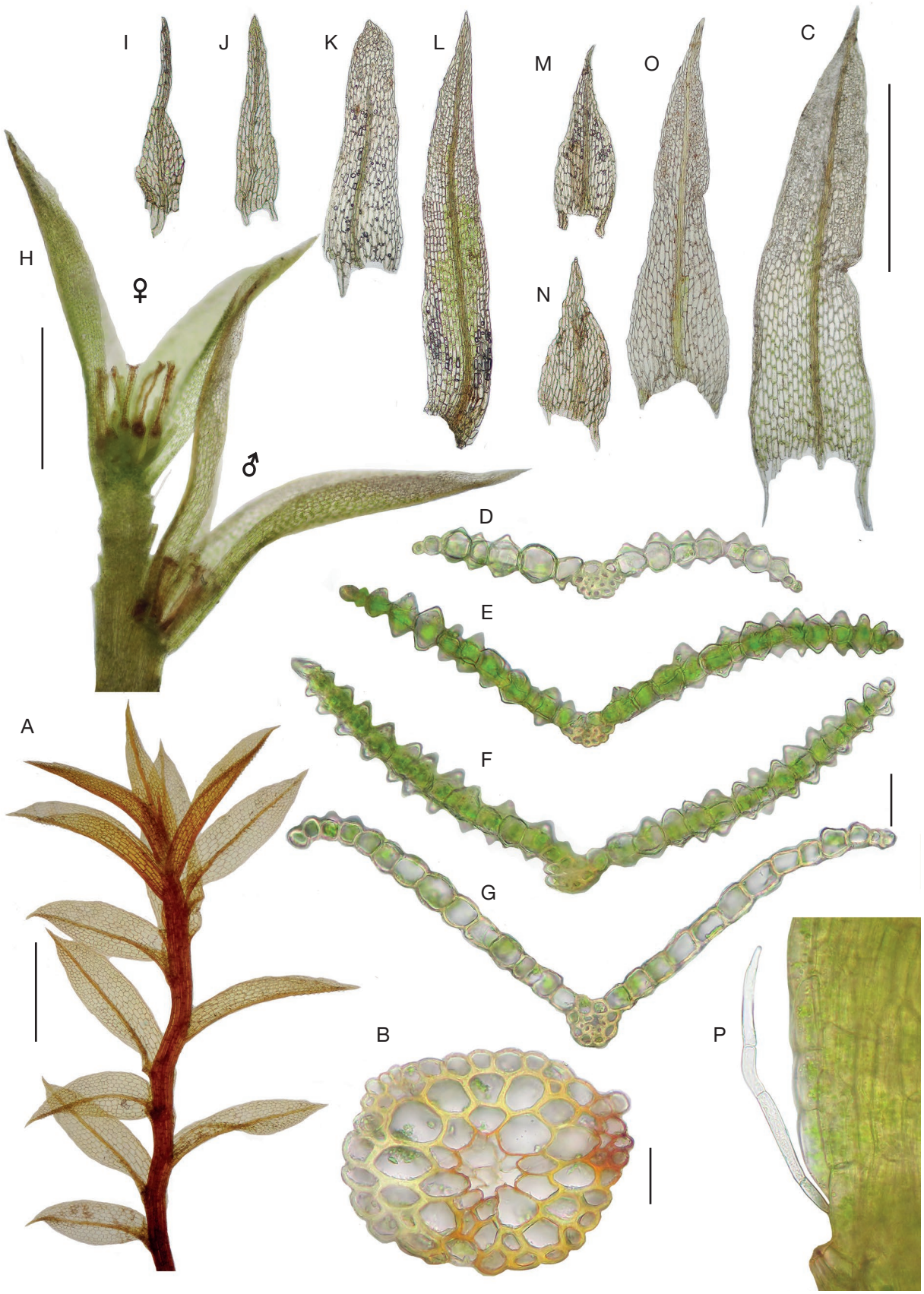

FIG. 2. – *Koponobryum papillosum* Printarakul & Chantanaorr., sp. nov.: **A**, KOH color reaction of plant; **B**, cross section of stem; **C**, vegetative leaf; **D**-**G**, cross sections of leaf from upper to base; **H**, perichaetium and perigonium; **I**-**L**, perichaetial leaves; **M**-**O**, perigonial leaves; **P**, axillary hair. Photos by N. Printarakul. All from *N. Printarakul & K. Adulkittichai 19072020_1* (CMUB). Scale bars: A, 1 mm; B, D-G, P, 25 µm; C, H-O, 0.5 mm.

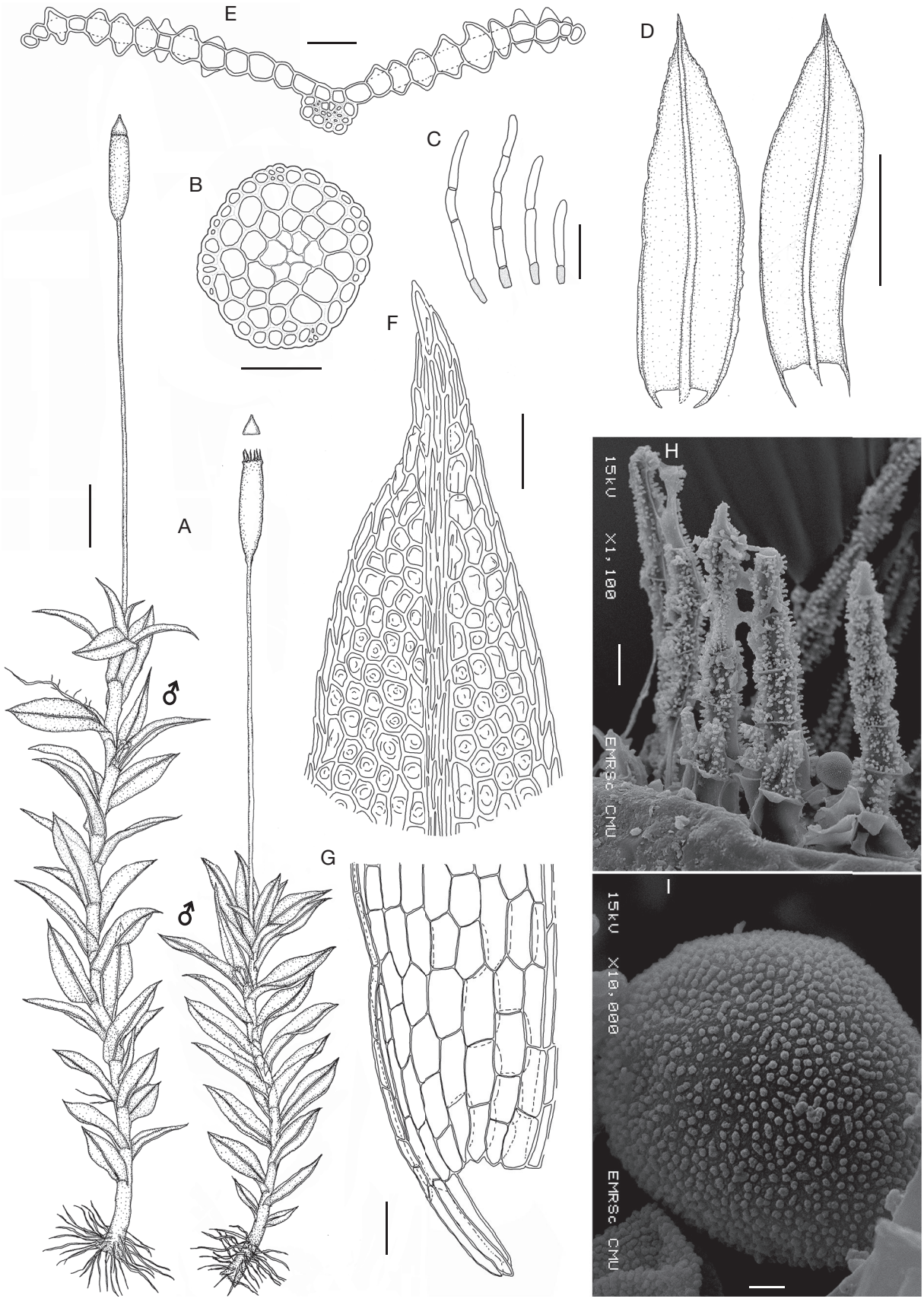

Fig. 3. – *Koponobryum papillosum* Printarakul & Chantanaorr., sp. nov.: **A**, plants with sporophytes; **B**, cross section of stem; **C**, variations of axillary hairs; **D**, leaves; **E**, cross section of midleaf; **F**, leaf apex; **G**, leaf base; **H**, peristome (SEM); **I**, spore (SEM). A-G. Drawn by N. Printarakul. All from *N. Printarakul & K. Adulkittichai 19072020_1* (CMUB). Scale bars: A, 1 mm; B, C, F, G, 50 µm; D, 0.5 mm; E, 25 µm; H, 10 µm; I, 1 µm.

Asexual reproduction
Not seen.

Autoicous
Perigonia
Lateral on short branches, perigonial leaves ovate to lanceolate, smaller than stem leaves, apex acute to acuminate, margins entire; antheridia 10-15 per perigonium; paraphysis absent.

Perichaetia
Terminal, perichaetial leaves ovate-lanceolate, seldom lingulate, smaller than stem leaves or sometimes rudimentary, apex acute to acuminate or sometimes obtuse, margins entire, weakly sheathing at base; paraphyses absent.

Setae
4-6 mm long, smooth, yellowish brown in upper part, reddish in lower part.

Capsules
Erect, symmetrical, oblong-cylindrical, up to 1.3 mm long, smooth.

Opercula
Conical, reddish brown, *c*. 0.25 mm long.

Peristome
Single, reddish brown, consisting of 16 linear teeth, 175-190 µm high, papillose.

Spores
Spherical, 12.5-15 µm in diameter, finely papillose.

Calyptra
Cucullate, smooth.

Taxonomic notes
The new species is characterized by a combination of the following characters: 1) autoicous sexual condition; 2) orange to red coloration in KOH; 3) lanceolate to oblong-lanceolate leaves with acute to acuminate apex and decurrent base; 4) a short-excurrent costa with single stereid band in cross section; 5) leaf bordered by 1-3 rows of elongate cells; 6) leaf margins being serrulate to denticulate above the midleaf; 7) upper laminal cells bearing a central papilla on both sides; 8) filiform axillary hairs composed of 2-5(6) cells long; and 9) oblong-cylindrical capsules with conical operculum; 10) peristome consisting of 16 linear papillose teeth; and 11) papillose spores.

Koponobryum papillosum Printarakul & Chantanaorr., sp. nov. resembles the type species of the genus, *K. bengalense*, in having bordered leaves consisting of 1-3 rows of elongate cells, leaf apex being acute to acuminate, the upper lamina cells having a central papilla on both sides, and central strand distinctly differentiated. *Koponobryum bengalense*, however, differs from the new species by dioicous plants, smooth spores, and axillary hairs consisting of two short basal cells and one longer apical cell.

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