TWO NEW MOSS SPECIES, TRICHOSTELEUM FLEISCHERI AND SPLACHNOBRYUM TEMASEKENSIS, FROM SINGAPORE

BENITO C. TAN¹, BOON-CHUAN HO¹ AND BRANDON KWEE-BOON SEAH¹

ABSTRACT. The diversity of moss flora of Singapore is briefly reviewed. Twenty new moss records have been documented in the past six years. Two species, Trichosteleum fleischeri B.C.Tan, B.-C.Ho & B.K.-B.Seah and Splachnobryum temasekensis B.C.Tan, B.-C.Ho & B.K.-B.Seah, are described as new to science with the type locality in Singapore.

Despite its small area totalling about 640 sq km and a long history of forest clearing for settlements and urbanization (Corlett 1991), the Republic of Singapore, surprisingly, has an impressive moss flora reportedly consisting of 168 species of mosses in 58 genera, of which 93 taxa are still extant today. These include 20 new records documented in the past six years. The new records are Barbula subcomosa Broth., Claopodium prionophyllum (Muell.Hal.) Broth., Fissidens autoicus Dixon, F. crenulatus Mitt. var. elmeri (Broth.) Z.Iwats. & Tad.Suzuki, F guangdongensis Z.Iwats. & Z.-H.Li, F gymnogynus Besch., F oblongifolius Hook.f. & Wilson, F pallidinervis Mitt., F pallidus Hook.f. & Wilson, F polyiodioides Hedw., F pseudoceylonensis B.C.Tan & M.-S.Choy, Leucobryum chlorophyllum Muell. Hal., Ochroberyum kurzianum Mitt., Papillidiopsis ramulina (Thwaites & Mitt.) W.R.Buck & B.C.Tan, Philonotis hastata (Duby) Wijk & Margad., P. mollis (Dozy & Molk.) Mitt., P. thwaitesii Mitt., Pseudotaxiphyllum pohliaecarpum (Sull. & Lesq.) Z.Iwats., Pterogonidium pulchellum (Hook.) Muell. Hal. and Syrrhopodon aristifolius Mitt. (cf. Mohammed and Tan 1988; Tan and Choy 2002). Of these, Claopodium prionophyllum and Syrrhopodon aristifolius were collected only in 2003 for the first time from Singapore. On the other hand, Ochroberyum kurzianum and Pterogonidium pulchellum were shown to be alien species introduced as a result of horticultural activity (Tan and Tan 2000; Tan and Buck 2002). It is therefore of significance that we report here two species of mosses collected from Singapore that are new to science.

(1) Trichosteleum fleischeri B.C. Tan, B.-C. Ho & B.K.-B. Seah, sp. nov. (Sematophylaceae)
Holotype: Singapore, Bukit Timah, 6 Mar 1898, M. Fleischer (H-BR; isotype, SINU).
Paratype: Upper Peirce Reservoir forest, on soil and root base, Seah K-B. 437, 438 (SINU); MacRitchie Reservoir, damp soil, edge of forest, 16 Apr 2002, R. Caveny & B.C. Tan 51 (SINU); ibid, trail margin, 5 Oct 2003, Ge Xiaowei s.n. (SINU); Kent Ridge, near DBS, National University of Singapore, 12 Jun 2003, Toh H.-B. s.n. (SINU).

Trichosteleum lutschianum proximum, foliis falcatoribus late ovato-oblanceolatis, acumine latiore differt.

Plants medium-sized to relatively robust, forming extensive, loose, to dense, yellowish

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green mats. Stems smooth, light brown, irregularly branched, bearing light reddish brown, and usually unbranched rhizoids at irregular intervals; branches attached to main stem at wide angle, short to long, 0.5–20 mm long and 2–3 mm wide including leaves, weakly complanate. Cross-section of stem with 2–3 rows of thick-walled cells surrounding a core of larger, thin-walled cells; central strand absent. Leaves monomorphic between stem and branches, erect-spreadling, somewhat falcate, ovate-lanceolate, 1.5–2.4×0.31–0.62 mm, narrow above, forming slightly to somewhat constricted acumen, acuminate, slightly to moderately concave, weakly to moderately unipapillose over the cell lumina in upper 2/3 of the lamina; margins without a border, somewhat undulate, narrowly reflexed, weakly serrulate almost to base, ecostate. Laminal cells elongate to linear, 150–230×ca 6 μm, becoming shorter and broader towards the tip; basal leaf cells more or less thick-walled, incrassate at insertion; alar cells greatly enlarged and inflated, arranged in a row of 3–4 cells, oblong, 75–100(–170)×20–50 μm, thin-walled, often coloured, with a few smaller, thin-walled supra-alar cells. Autoicous? Perigonia not seen. Perichaetia conspicuous, scattered along primary stems; archegonia numerous, up to 40 per perichaetium; leaves erect, mostly lanceolate, to 1.2 mm long, long acuminate; margins mostly serrate above; costa none; cells linear above, laxly rectangular below, weakly papillose to almost smooth; alar cells weakly to not differentiated. Setae slender, 1.5–2.0 cm long, reddish, smooth throughout. Capsule small, inclined to pendulous; urn ovate, ca. 1 mm long×0.3 mm wide, symmetrical; exothelial cells ovate to rounded, strongly collenchymatous, mammilllose; stomata near base of capsule, on top of protuberances, guard cells two, round; annulus not seen; operculum obliquely long-rostrate, as long as the urn. Peristome double, exostome teeth with a zig-zag center line or a median furrow, papillose above, cross-striolate below with over-lying papillae; endostome with a high basal membrane, ca 1/3 of total endostomial height, finely papillose, cilia almost as long as segments, usually single. Spores small, 13–15 μm across, green. Calyptra naked.

Habitat: in disturbed lowland rain forests, shaded to semi-shaded, usually found on moist, clayey soil along forest paths or walk ways, sometimes on boulders.

The new species belongs to Trichosteleum sensu Buck and Tan (1989) and Tan and Jia (1999). According to these authors, Trichosteleum is distinguished from Papillidiopsis (Broth.) W.R. Buck & B.C. Tan in having less concave leaves with gradually acute or acuminate leaf apices. Members of Papillidiopsis have strongly concave leaves with a well marked, constricted distal acumen. The oblong apical cells of Papillidiopsis are nearly always shorter than the narrowly elongate to linear laminal cells. This difference in the leaf cell length is not seen in Trichosteleum. Furthermore, the enlarged alar cells of Papillidiopsis are frequently thick-walled and coloured but not in Trichosteleum.

Fig. 1–8. Trichosteleum fleischeri (based on holotype at SINU). 1, vegetative leaves. 2, apical branch. 3, cross-section of stem. 4, apical laminal cells. 5, marginal laminal cells. 6, basal laminal cells showing alar differentiation. 7, capsule. 8, perichaetium. [Scale: bar length for figs. 1, 7, & 8 is 1 mm; bar length for fig. 2 is 2 mm; bar length for figs. 3–6 is 100 μm].
However, the new species also possess characters of *Papillidiopsis*, such as having a large plant size, somewhat constricted leaf apices, and a moderately concave leaf with narrowly reflexed leaf margins. Nevertheless, of all the characters observed in the new species, we consider the general leaf outline, the weakly to moderately concave leaf shape, the elongate apical leaf cells, the thin and colourless alar cell walls, the absence of strongly constricted leaf acumen, the papillose perichaetial leaves and mammilllose exothecial cells, to be the important features relating it to *Trichosteleum* rather than to *Papillidiopsis*.

Unfortunately, there is no recent taxonomic revision of species of *Trichosteleum* in the Asian tropics. Our new species of *Trichosteleum* from Singapore does not match the descriptions, neither does it compare satisfactorily with herbarium specimens of any of the taxa described or reported in Bartram (1939), Fleischer (1923), Mohammed and Tan (1988), and Tan & Jia (1999). We conducted therefore a comparison of the leaf morphology between the new species and other seemingly related Malesian species of *Trichosteleum* and *Papillidiopsis*, and the results are shown in Table 1.

It is apparent from Table 1 that the new species is distinctive even though somewhat variable in plant size. Its closest species seems to be *Trichosteleum lutschianum* (Broth. & Paris) Broth. from China and Japan. However, careful comparison between the two taxa reveals significant differences. In *T. lutschianum*, plants have stronger falcate leaves that are narrowly ovate-lanceolate with long slender and sharp acumina. Leaf margins are entire except for the weakly serrulate leaf tips. Laminal cells are weakly papillose to almost smooth on the upper half of the leaves. In contrast, *T. fleischeri* has only somewhat falcate leaves that are more broadly ovate-lanceolate, usually with broader leaf acumina. Its leaf margins are more toothed in the upper 1/2–2/3 of the leaf, often sharply so in the acumen. The laminal cells are moderately papillose on the upper 1/2–2/3 of the leaf and the single papilla on the cell lumen is always stronger in expression than that seen in *T. lutschianum*.

Some specimens of the new species can be confused with *Trichosteleum stigmosum* Mitt. However, *T. fleischeri*, in general, is a more robust plant, with longer secondary branches whose leaves are more widely erect-spreading when dry. Compared with the new species, the leaf cells of *T. stigmosum* are more strongly unipapillose.

*Trichosteleum fleischeri* can also be mistaken for *Papillidiopsis malayana*. The latter has an oblong-lanceolate leaf outline and much longer and narrower leaf apices, whereas *T. fleischeri* has more broadly ovate-lanceolate leaves with stronger leaf marginal teeth.

This new species has an interesting history of discovery. It was first collected by Fleischer on March 6, 1898, from Bukit Timah in Singapore. A packet is preserved at the Brotherus Herbarium (H-BR!) at the University of Helsinki, with a handwritten provisional name, “Rhaphidostichum cuspidatum, n. sp. Flesch., ined.” Subsequently, the taxon has been reported in a number of local publications as “Trichosteleum cuspidatum”. We think that it is most appropriate to name the new species formally in honour of M. Fleischer, its discoverer!

To date, we have collected the species from several places in Bukit Timah Nature Reserve, the nearby MacRitchie Reservoir forest, and even on NUS campus. The new species is rather widespread on the island and appears to be well adapted to semi-open and disturbed habitats, such as trail margins and grassy landscapes. Its presence in the nearby
Table 1. A comparison of the new species and other related species of *Trichosteleum* and *Papillidiopsis*. All characters are based on the type specimens of the taxa.

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<tbody>
<tr>
<td>Leaf concavity</td>
<td>Moderate to strong</td>
<td>Moderate</td>
<td>Strong</td>
<td>Strong</td>
<td>Moderate, rarely strong</td>
<td>Moderate, rarely strong</td>
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<tr>
<td>Leaf shape</td>
<td>Lanceolate to oblong-lanceolate</td>
<td>Broadly oblong-lanceolate</td>
<td>Oblong-lanceolate</td>
<td>Lanceolate to oblong-lanceolate</td>
<td>Ovate-lanceolate</td>
<td>Ovate-lanceolate</td>
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<tr>
<td>Leaf size: 1:w(mm)</td>
<td>1.4–1.8× 0.30–0.45</td>
<td>1.6–1.8× 0.35–0.45</td>
<td>1.1–1.5× 0.30–0.35</td>
<td>1.6–2× 0.30–0.35</td>
<td>1.4–2×0.2–0.5</td>
<td>1.5–2.5× 0.3–0.65</td>
</tr>
<tr>
<td>Leaf marginal serration</td>
<td>Serrate at upper 1/2</td>
<td>Subentire, weakly serrulate at the tip</td>
<td>Serrulate at upper 1/2</td>
<td>Serrulate at upper 1/2</td>
<td>Subentire, serrulate at the tip</td>
<td>Serrulate almost to base</td>
</tr>
<tr>
<td>Leaf acumen</td>
<td>Ligulate, 0.2–0.5 mm; short acuminate to acute; strongly constricted</td>
<td>Short, 0.1–0.2 mm; broadly acuminate to acute, strongly constricted</td>
<td>Short, 0.1–0.2 mm; narrowly acuminate, strongly constricted</td>
<td>Very long, narrow, 0.4–0.6 mm; sharply acuminate, constricted</td>
<td>Elongate, 0.5–1 mm; sharply acuminate; somewhat constricted</td>
<td>Elongate, 0.3–0.7 mm; acuminate; somewhat constricted at times</td>
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<tr>
<td>Leaf cell uni-papillosity</td>
<td>Strongly papillose on upper 2/3</td>
<td>Variable papillose on upper 1/3 to almost smooth</td>
<td>Strongly papillose on upper 2/3</td>
<td>Moderate to weakly papillose on upper 1/2</td>
<td>Weakly papillose on upper 1/2</td>
<td>Moderate to weakly papillose on upper 2/3</td>
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<tr>
<td>Leaf apical cells</td>
<td>Rhomboidal</td>
<td>Ovate-rhomboidal</td>
<td>Oblong-elongate</td>
<td>Oblong-rhomboidal</td>
<td>Oblong-linear</td>
<td>Elongate to linear</td>
</tr>
<tr>
<td>Median leaf cells</td>
<td>Elongate, fusiform</td>
<td>Elongate, fusiform</td>
<td>Elongate, fusiform</td>
<td>Elongate, fusiform</td>
<td>Narrowly elongate</td>
<td>Elongate to linear</td>
</tr>
<tr>
<td>Leaf alar cell walls</td>
<td>Thin to thick</td>
<td>Often thick</td>
<td>Thin to thick</td>
<td>Thin</td>
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Malaysian State of Johor can be expected.

(2) *Splachnobryum temasekensis* B.C. Tan, B.-C. Ho and B.K.-B. Seah, *sp. nov.* (Spachnobryaceae)
Holotype: Rocky slope beside Temasek Life Sciences Laboratory, Apr 2003, Pui Cui-Fen, s.n. (SINU).

*Splachnobryo oorschotii* in *foliis forma similis, caule multo breviore, foliis erectis ad erectopatentibus differt.*

Plants small, 0.5 to 2 mm long, including the leaves. Stem short, erect, unbranched, dark- to medium-green, ca 0.5 to 1 mm tall, often less, causing the plants to appear “stem-less”. Rhizoids brown. Leaves spreading, oblong-lingulate to ligulate, 1–1.5 mm long × ca 0.2 mm wide, apex obtuse to rounded, costa single, ca 65 μm in width at base, ending several cells (3–5) below the apex, abaxially spinulose-prorate near apex; leaf margins plane, but sometimes slightly recurved in middle part of the leaf, entire below and crenulate above, the marginal teeth near apex distinct and slightly forward-pointing. Lower laminal cells rectangular, ca 75 μm × 20 μm, smooth, mid laminal cells oblong, ca 30 μm × 15 μm, mostly smooth, at times weakly to moderately unipapillose; upper and apical laminal cells rhomboidal and oval, about 15 μm long, arranged in 1–2 horizontal rows apically. Apparently dioicous. Only male plants seen. Perigonial leaves like vegetative leaves, oblong-lingulate, but smaller in size and with more expanded leaf base. Antheridia oblong to cylindrical, about 220 μm long, green when immature, brown when mature. Female plants and sporophyte not seen.

The genus *Splachnobryum* has been monographed recently by Arts (2001) who accepted six species for Malesia. The obtuse leaf apex and the distinctive apical leaf areolation were shown by the author to be a dependable diagnostic character for the genus. Accordingly, one species from India with the autapomorphic characters of unipapillose leaf cells and acute leaf apex has been segregated to represent a new genus, *Koponobryum* Arts. On the basis of these differences, our new species is rightfully a member of *Splachnobryum*.

However, none of the six species of *Splachnobryum* found in Malesia resemble the new species (Arts 2001, see also Eddy 1996), which grows to only about 1–2 mm tall, including the leaves, making it the shortest species in the genus. The other remarkable features of the new species are the narrowly lingulate to ligulate leaves with obtuse to round leaf apices and the presence of some unipapillose leaf cells. The last mentioned character appears to be the apomorphic character linking *Splachnobryum* to *Koponobryum* in the family.

In our evaluation, the closest species of *S. temasekensis* is *S. oorschotii* (Sande Lac.) Müll. Hall., which also occurs in Singapore. But unlike the new species, the latter has stem growing to 10–15 mm tall, a somewhat different growth habit and leaf outline, and with only smooth leaf cells.

Interestingly, only the male plants are known in *S. temasekensis*. No female plants were seen in the type locality. In this genus there are two species known only from female
Fig. 9–17. *Splachnobryum temasekensis* (based on holotype at SINU). 9, entire plant. 10–11, leaves. 12–13, leaf apices. 14, upper leaf margin. 15, lower leaf margin showing the narrowly recurved margin (shaded). 16, lower leaf margin near base. 17, antheridium.
plants. For other species of *Splachnobryum* where both sexes are known, the male and female plants are of slightly different sizes (see illustrations in Arts 2001). Because of this, we do not think that the new species represents the extremely reduced male plants of either one of the two species of *Splachnobryum* known only by the female plants in the region.

The small and inconspicuous plants of the new species are only known from the type location at present. Like other species of the genus, it is probably also an ephemeral and adventive taxon exploiting the presence of favourable moist soil microhabitats that come and go. Being the only species in the genus that has the unique combination of smooth and papillose leaf cells, its protection from extinction is highly recommended. This is, no doubt, a formidable challenge to the local community to undertake.

The species epithet, “temasekensis”, not only commemorates the type locality, the Temasek Life Science Laboratory, situated on Kent Ridge at the National University of Singapore, but is also an old name of the island of Singapore in the local dialect.

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**Literature Cited**