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A contribution to the *Fissidens* Hedw. (Musci, Fissidentaceae) of Myanmar, including *F. strictidens* sp. nov. and *F. pseudoanomalus* sp. nov.

Maria A. BRUGGEMAN-NANNENGA & Frank MÜLLER

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A contribution to the *Fissidens* Hedw. (Musci, Fissidentaceae) of Myanmar, including *F. strictidens* sp. nov. and *F. pseudoanomalus* sp. nov.

Maria A. BRUGGEMAN-NANNENGA

Griffensteijnseplein 23, NL-3703 BE Zeist (The Netherlands)

Frank MÜLLER

TU Dresden, Institut für Botanik, D-01062 Dresden (Germany)

frank.mueller@tu-dresden.de (corresponding author)

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ABSTRACT

Fissidens strictidens Brugg.-Nann. & Frank Müll., sp. nov., belonging to *Fissidens* subg. *Aloma* Kindb., and *Fissidens pseudoanomalus* Brugg.-Nann. & Frank Müll., sp. nov., belonging to *Fissidens* subg. *Pachyfissidens* (Müll.Hal.) Kindb. sect. *Pachyfissidens*, are described and figured from material collected in Kachin State, Myanmar. *Fissidens biformis* Mitt., *Fissidens crispulus* var. *robinsonii* (Broth.) Z.Iwats. & Z.H.Li, *Fissidens guangdongensis* Z.Iwats. & Z.H.Li, *Fissidens linearis* var. *obscuriretis* (Broth. & Paris) I.G.Stone, *Fissidens pokhrensensis* Nork. ex S.S.Kumar, *Fissidens serratus* Müll.Hal., and *Fissidens wichurae* Broth. & M.Fleisch. are newly recorded for Myanmar.

RÉSUMÉ

Contribution au genre *Fissidens* Hedw. (Musci, Fissidentaceae) de Myanmar, dont *F. strictidens* sp. nov. and *F. pseudoanomalus* sp. nov.

Fissidens strictidens Brugg.-Nann. & Frank Müll., sp. nov., appartenant au sous-genre *Aloma* Kindb., et *Fissidens pseudoanomalus* Brugg.-Nann. & Frank Müll., sp. nov., appartenant au sous-genre *Pachyfissidens* (Müll.Hal.) Kindb. sect. *Pachyfissidens*, sont décrits et illustrés à partir du matériel collecté dans l'Etat de Kachin, Myanmar. *Fissidens biformis* Mitt., *Fissidens crispulus* var. *robinsonii* (Broth.) Z.Iwats. & Z.H.Li, *Fissidens guangdongensis* Z.Iwats. & Z.H.Li, *Fissidens linearis* var. *obscuriretis* (Broth. & Paris) I.G.Stone, *Fissidens pokhrensensis* Nork. ex S.S.Kumar, *Fissidens serratus* Müll.Hal., et *Fissidens wichurae* Broth. & M.Fleisch. sont nouveaux pour le Myanmar.

KEY WORDS

Asia,
Fissidens,
Fissidentaceae,
mosses,
Myanmar,
new records,
new species.

MOTS CLÉS

Asie,
Fissidens,
Fissidentaceae,
mousses,
Myanmar,
signalements nouveaux,
espèces nouvelles.

INTRODUCTION

In the course of biodiversity transect studies along elevational gradients in Myanmar from 2012–2014 (Mt Victoria, Natma Taung National Park, Chin State; Hponyin Razi and Hponkan Razi NW of Putao, Kachin State), Georg Miehe and colleagues collected an extensive number of bryophyte specimens. This material was sent to the second author for further processing and determination. Comprising 2350 specimens, this material represents one of the world's largest collections of bryophytes from Myanmar. Among them are several species of *Fissidens* Hedw., a genus of mosses hitherto insufficiently known for the country.

In their checklist of Myanmar mosses, Tanaka *et al.* (2003) reported 20 species of *Fissidens* from Myanmar, namely *F. anomalus* Mitt., *F. beckettii* Mitt., *F. bryoides* Hedw., *F. ceylonensis* Dozy & Molk., *F. circinalis* Mitt., *F. crenulatus* Mitt. (as *F. semperfalcatus* Dixon), *F. crispulus* Brid. (as *F. zippelianus* Dozy & Molk.), *F. diversifolius* Mitt., *F. dubius* P.Beauv. (as *F. cristatus* Mitt.), *F. flaccidus* Mitt. (as *F. maceratus* Mitt.), *F. ganguleei* Nork., *F. gardneri* Mitt. (as *F. microcladus* Thwaites & Mitt.), *F. hollianus* Dozy & Molk., *F. javanicus* Dozy & Molk., *F. nobilis* Griff., *F. papillulosus* Broth., *F. pellucidus* Hornsch. (as *F. laxus* Sull. & Lesq.), *F. polypodioides* Hedw., *F. thwaitesii* Par., and *F. zollingeri* Mont. In other sources we have found two additional species cited for Myanmar, namely *Fissidens kurzii* Müll.Hal. (Suzuki & Iwatsuki 2010) and *Fissidens involutus* P.S. Wilson ex Mitt. (Li & Iwatsuki 2001).

Specimens of *Fissidens* collected by Miehe *et al.* were determined by the second author and sent to the first author for verification. Voucher specimens are in the herbaria of Technische Universität Dresden (DR) and private herbarium Bruggeman-Nannenga and L (types). The collection includes 15 taxa of *Fissidens*, of which two are new to science and seven represent new records for Myanmar.

NEW SPECIES

Family FISSIDENTACEAE Schimp.
Genus *Fissidens* Hedw.

Fissidens strictidens Brugg.-Nann. & Frank Müll., sp. nov.
(Figs 1; 2)

DIAGNOSIS. — The species is characterized by pluripapillose cells and limbidia restricted to the vaginant lamina. It differs from its congeners by stiff, erect, almost completely divided peristome teeth.

HOLOTYPE. — Myanmar, Kachin State, Hponkan Razi, epiphytic in evergreen broadleaved forest, mixed with *F. serratus* Müll.Hal. and *F. pokhrensii* Nork. ex S.S. Kumar, 1565 m, 27.548702N, 97.032742E, 14.X.2014, J. Kluge & P.K. Kine 14-031-001b-B (holo-, DR; iso-, L).

DESCRIPTION

Growing scattered between other mosses and hepatics on bark.

Stems

3–4 × 1.5–2 mm, hardly heterocaulous, pinnately foliated, unbranched, some stems with perichaetial branches in axils of subperichaetial and perichaetial leaves of old perichaetia, without or with weak central strand.

Rhizoids

Brown, smooth.

Axillary nodules

Not differentiated.

Leaves

Close, up to 11 pairs, hardly crispate when dry, elliptic-lanceolate with acute-acuminate apex, (0.9–)1–1.2(–1.3) × (0.2–)0.3 mm, 3.5–4.1(–5.2) times as long as wide, margin crenulate, limbate on the vaginant laminae of all well-developed leaves of perichaetial stems, limbidium reaching ± ½ the length of the vaginant lamina in perichaetial leaves, in mid leaves consisting of a few elongated cells only, marginal, reaching insertion of vaginant laminae, up to 19 µm wide, unistratose; vaginant laminae ± ½ the leaf length, at base less wide than the stem, rounded at insertion, ± decurrent, unistratose, slightly unequal; basal part of dorsal lamina rounded, reaching the insertion, not decurrent; dorsal and apical lamina unistratose.

Costa

Percurrent to excurrent, in cross-section bryoides-type.

Lamina

Of mid dorsal laminal cells (3–)3.5–5(–6) × (2–)3–4.5(–5.5) µm, 3–4 papillose. Of mid vaginant laminal cells oblong, (5–)5.5–8(–9.5) × (2.5–)3–4.5(–5.0) µm, 3–4 papillose.

Gemmae

Not observed.

Fertile parts

Perigonia and perichaetia on the same stem, perigonia terminal on ± stemless, 0.4–0.5 mm long branches; antheridia 200 µm long; perichaetia terminal on main stems and short, circa 0.35–0.4 mm long branches, archegonia 250–265 µm long, perichaetial leaves 1.5 mm long; calyptra not observed. Sporophyte, seta 2 mm long, smooth, 1 per perichaetium; capsule erect, 0.6 × 0.3 mm, with ± 32 columns of quadratic-oblong exothecial cells, with stomata; peristome anomalous, teeth erect, ± completely divided (Fig. 1A); operculum not observed; spores subglobose, (7.0–)7.5–9.5(–11.5) × (5.0–)6–7.5(–10.5) µm, papillose.

DISCUSSION

The new species is characterized by its corticolous habitat, pluripapillose cells and limbidia restricted to the vaginant lamina. The limbidia are found in upper and mid leaves of perichaetial stems and extend about half the length of the vaginant laminae in perichaetial leaves. Its best diagnostic characters are the stiff, erect, almost completely divided peristome teeth (Fig. 1A, B).

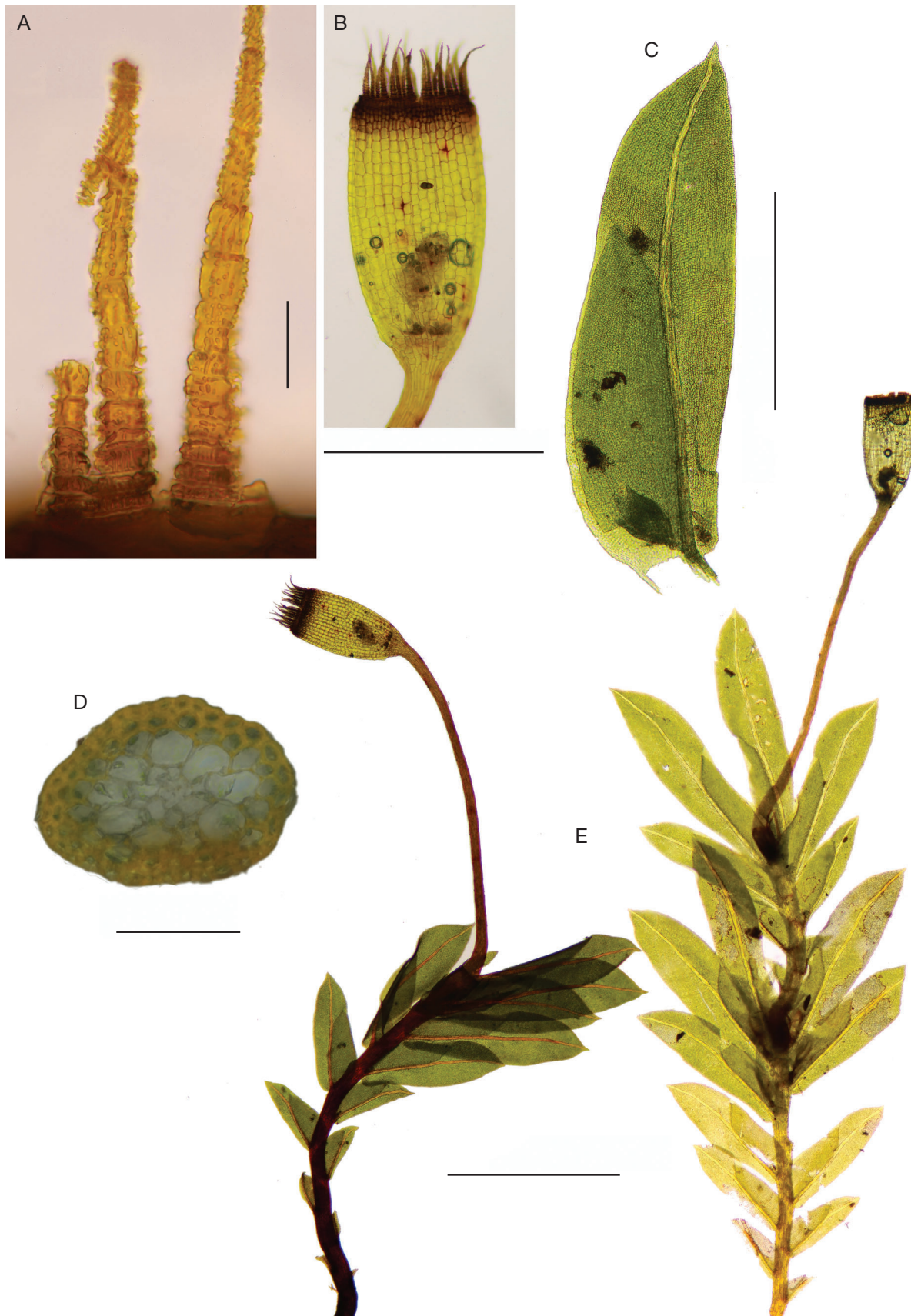


FIG. 1. — *Fissidens strictidens* sp. nov.: **A**, peristome teeth; **B**, capsule; **C**, leaf; **D**, stem cross section; **E**, sporophytic stems. All from the holotype J. Kluge & P.K. Kine 14-031-001b-B. Scale bars: A, 20 µm; B, C, 0.5 mm; D, 50 µm; E, 1 mm.

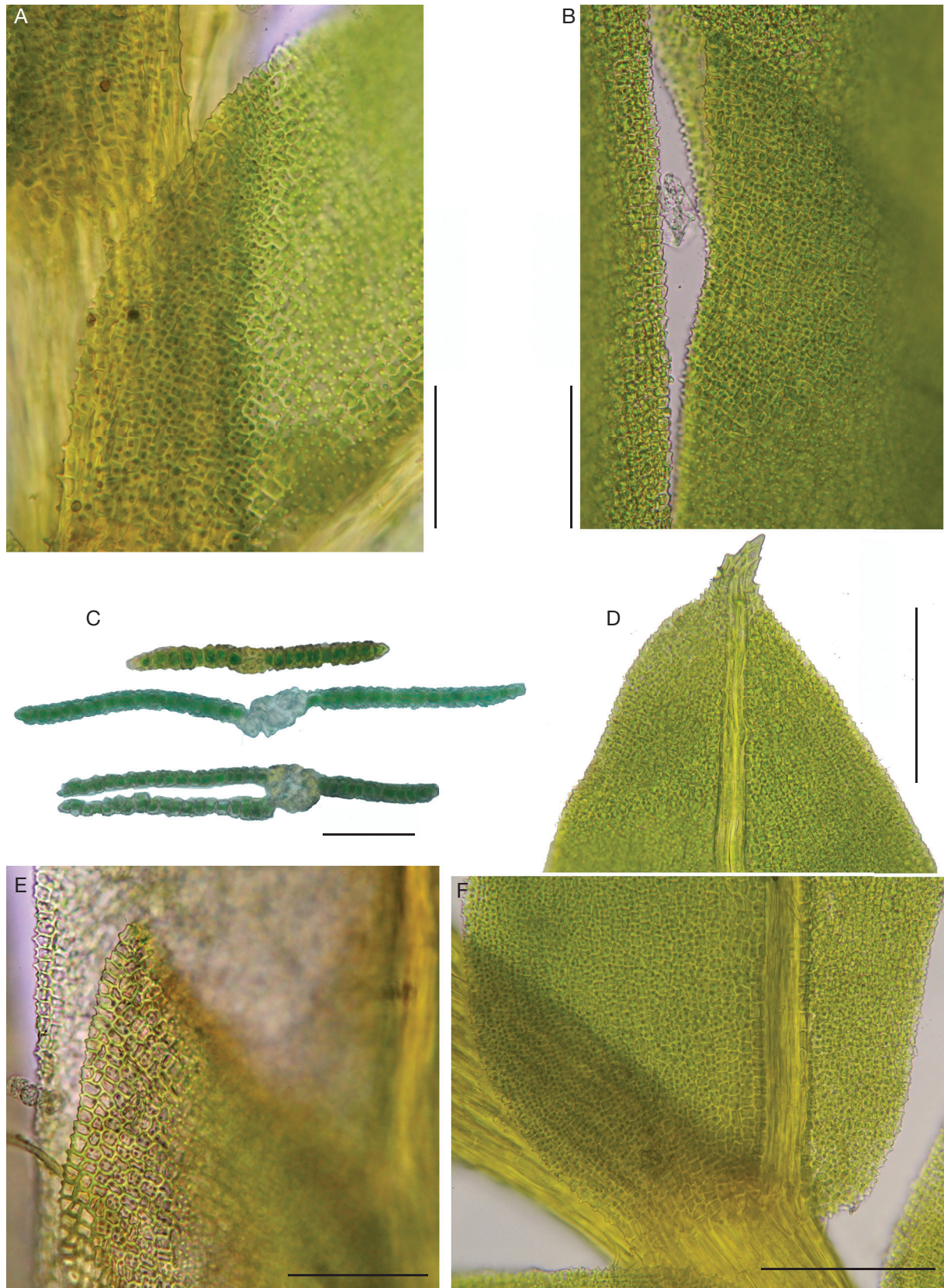


FIG. 2. — *Fissidens strictidens* sp. nov.: **A**, basal part of vaginant lamina showing the short, weak limbidium; **B**, mid leaf; **C**, trans sections of leaves; **D**, leaf apex; **E**, upper part of vaginant lamina; **F**, leaf insertion. All from the holotype *J. Kluge & P.K. Kine 14-031-001b-B*. Scale bars: A-C, E, 50 µm; D, F, 100 µm.

Gametophytically it closely resembles *F. linearis* var. *obscurirete*, *F. pokhrensensis* and *F. kurzii*. All three have pluripapillose cells, but differ from the new species in having scarious-type peristomes. Species with pluripapillose cells and limbidia restricted to the vaginant laminae belong to the gametophytically heterogeneous subgenus *Aloma* (Pursell & Bruggeman-Nannenga 2004). The sporophyte of this subgenus is characterized by ± 32 columns of exothecial cells on the capsule periphery, a scarious-type of peristome (though anomalous peristomes frequently occur) and by, though this was not mentioned by Pursell & Bruggeman-Nannenga (2004), long rostrate opercula (versus shortly and bluntly rostrate in subg. *Fissidens*).

It is interesting to note that anomalous peristomes are frequently found in corticolous species, e.g. in the Indian *F. macrosporus* Mitt., the Japanese *F. neomagofukui* Z. Iwats. & Tad. Suzuki, the pantropical *F. lagenarius* Mitt. and *F. gardneri* Mitt. and the African species *F. macroglossus* (Broth.) Brugg.-Nann. and *F. cyatheicola* Brugg.-Nann.

Fissidens pseudoanomalus

Brugg.-Nann. & Frank Müll., sp. nov.
(Figs 3-5)

DIAGNOSIS. — The species closely resembles *Fissidens anomalus* Mont., but differs in the structure of the leaf border zone which is in part bistratose and contains elongated cells.

HOLOTYPE. — Myanmar, Hponyin Razi, *Lithocarpus-Magnolia-Rhododendron* forest, 2632 m, 27.616607N, 96.982848E, 30.X.2013, G. Miede et al. 13-076-075-F (holo-, DR; iso-, L).

FURTHER SPECIMENS EXAMINED (paratypes). — Myanmar, Kachin State, Hponkan Razi, evergreen broadleaved forest, 1360 m, 27.58421N, 97.10447E, 24.X.2014, J. Kluge & P.K. Kine 14-050-12e-A (DR, private herbarium Bruggeman-Nannenga); Myanmar, Kachin State, Hponkan Razi, *Quercus-Magnolia-Araliaceae* forest, 1833 m, 27.603756N, 96.988924E, 16.XI.2013, G. Miede et al. 13-093-202-B (DR, private herbarium Bruggeman-Nannenga).

DESCRIPTION

Stems

Up to 35 mm long and up to 8 mm wide, pinnately foliated, sparsely to heavily branched, central strand well developed.

Rhizoids

Dark red-brown, heavily branched, smooth.

Axillary nodules

Not differentiated.

Leaves

Close to distant, up to 30 pairs, crispate when dry, lanceolate, often falcate, with acute-acuminate apex, $2.4-5.6 \times 0.4-0.95$ mm, 5-6 times as long as wide, margin coarsely serrate on dorsal and apical lamina, on the vaginant laminae serrulate with a few distant larger teeth; apical and dorsal lamina with pale, thickened, 3-5 cells wide, uni- to bistratose border of isodiametric and partly elongated cells, margin of vaginant lamina unistratose, hardly differentiated; vaginant laminae

$\frac{1}{2}-\frac{3}{5}$ the leaf length, rounded at insertion, unistratose, slightly unequal; dorsal lamina rounded-truncate below, reaching the insertion, not decurrent; dorsal and apical lamina unistratose.

Costa

Long excurrent, in cross-section taxifolius-type.

Lumina

Of mid dorsal laminal cells $(6.5-9.5-10.5(-13.0) \times (5-6.5-7.5(-9) \mu\text{m})$, walls smooth, convex, thin, $1-1.5 \mu\text{m}$ wide; lumina of mid vaginant laminal cells $(8.5-10-10.7(-12.1) \times (5-6-6.9(-8.2) \mu\text{m})$; walls $2-3 \mu\text{m}$ wide, smooth; marginal cells of vaginant lamina with more incrassate, $3-4(-5) \mu\text{m}$ wide walls.

Gemmae

Not observed.

Fertile parts

Perigonia not observed. Perichaetia terminal on axillary, short, 1.6-2.5 mm long branches, archegonia $350-450 \mu\text{m}$ long, perichaetial leaves 1.5-2.1 mm long; calyptra not observed. Sporophyte, seta 3 mm long, smooth, 1 per perichaetium; capsule erect, 1.5×1.0 mm, with ± 94 columns of oblong exothecial cells with thick vertical walls, with stomata; peristome taxifolius-type, teeth deeply divided, $\pm 500 \mu\text{m}$ long, tooth-base $42-51 \mu\text{m}$ wide; operculum not observed; spores subglobose, $18.5-22(-25) \times 16-20 \mu\text{m}$, papillose.

DISCUSSION

The new species is easily recognized by its large size, the elimbate leaves with a pale, partly bistratose border-zone with elongated cells, coarsely serrate margins and lateral sporophytes with short setae and the reduced taxifolius-type peristome. It is closely resembles *F. anomalus* Mont. that has a similar sporophyte and a similar peristome. The two differ in the structure of the border zone. That of the new species is in part bistratose and contains elongated cells next to isodiametric cells. In *F. anomalus* the border zone is unistratose and composed of isodiametric cells. One of the paratypes, Miede et al. 13-093-202-B, differs from the other two in having bistratose areas in the dorsal lamina (Fig. 4C lowest cross section). In this respect it resembles *F. dubius* P.Beauv. and it will key out as that species (e.g., Li & Iwatsuki 2001). It can be distinguished from *F. dubius* by the structure of the border zone. That of *F. dubius* is unistratose and is composed entirely of isodiametric cells.

SPECIES NEW TO MYANMAR

Fissidens biformis Mitt.

F. angustifolius Sull., *Proceedings of the American Academy of Arts and Sciences* 5: 275 (1861).

SPECIMEN EXAMINED. — Myanmar, Natma Taung (Mt Victoria), terrestrial in evergreen oak forest with Taungya succession, 1200 m, 21.1885256N, 94.0797489E, 2.XI.2012, P. K. Kine 12_57_08a (DR, private herbarium Bruggeman-Nannenga).

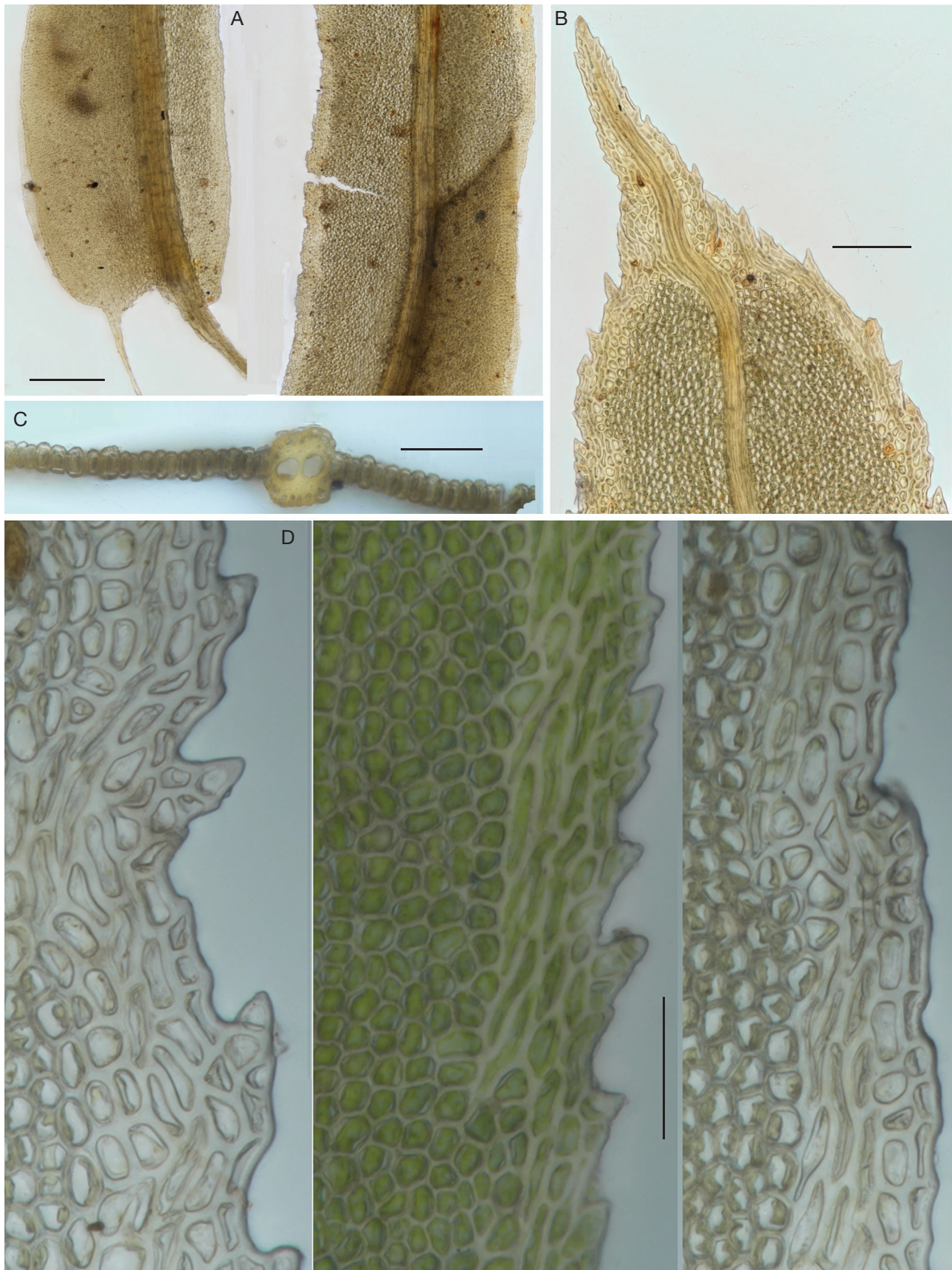


FIG. 3. — *Fissidens pseudoanomalus* sp. nov.: **A**, leaf near insertion (left) and mid leaf (right); **B**, leaf apex; **C**, trans section of leaf above the vaginant lamina; **D**, margins of mid leaf. A, B, C, D (right and left) from holotype G. Miehe et al. 13-076-075-F, D (middle) from G. Miehe et al. 13-093-202-B. Scale bars: A, 200 µm; B, 100 µm; C, D, 50 µm.



FIG. 4. — *Fissidens pseudoanomalus* sp. nov.: **A**, perichaetial branches; **B**, stem with perichaetial branches; **C**, part of trans section of leaf above vaginant laminae showing the bistratose border zone; **D**, leaves. A, C (two top cross sections), D from holotype *G. Miehe et al.* 13-076-075-F; B, C (lowest cross section) from *G. Miehe et al.* 13-093-202-B. Scale bars: A, 100 µm; B, D, 1 mm; C, 50 µm.

REMARKS

A Pantropical species, for a long time it was known as *F. angustifolius* Sull., but Bruggeman-Nannenga (2016) has shown *Fissidens bififormis* to be an older name. The species is known in Asia from China, India, Sri Lanka, Indonesia and Papua New Guinea (Daniels & Kariyappa 2013). In Asia the distribution of the species is insufficiently known, as some reports of *F. angustifolius* in the literature have been shown to belong to *F. zollingeri* (Bruggeman-Nannenga 2016).

Fissidens crispulus var. *robinsonii* (Broth.) Z.Iwats. & Z.H.Li

SPECIMENS EXAMINED. — Myanmar, Natma Taung (Mt Victoria), terrestrial in evergreen Oak forest with Taungya succession, 1200 m, 21.1885256N, 94.0797489E, 2.XI.2012, *P. K. Kine 12_57_05-A* & *12_57_08* (DR, private herbarium Bruggeman-Nannenga).

REMARKS

The taxon is widely distributed in tropical and subtropical regions of Asia (China, India, Philippines, Indonesia, Singapore, New Guinea, Malaysia, Laos, and South Korea), it is also known from New Caledonia, was reported as new for Africa by Shevock *et al.* (2013), and from the subtropical Kermadec Is in New Zealand by Beever (2014).

Fissidens guangdongensis Z.Iwats. & Z.H.Li

SPECIMENS EXAMINED. — Myanmar, Hponyin Razi, *Quercus-Magnolia*-Bamboo forest, 2209 m, 27.608888N, 96.980801E, 05.XI.2013, *G. Miede et al. 13-085-102* (DR, private herbarium Bruggeman-Nannenga); Myanmar, Natma Taung (Mt Victoria), epiphytic in evergreen Oak forest with Taungya succession, 1400 m, 21.2194427N, 94.0699586E, 25.X.2012, *P. K. Kine 12_46_11-C* (DR, private herbarium Bruggeman-Nannenga).

REMARKS

The species was described based on material from the province Guangdong in China (Li 1985), and was subsequently reported from Japan, Fiji, Singapore, Thailand, Philippines, Malaysia, Vietnam (Tan *et al.* 2000, 2006; Tan & Choy 2002; Ho 2015). It seems to be relatively widely distributed in tropical and subtropical regions of SE Asia.

Fissidens linearis var. *obscuriretis* (Broth. & Paris) I.G.Stone

SPECIMEN EXAMINED. — Myanmar, Kachin State, Hponkan Razi, evergreen broadleaved rainforest, epiphytic, 1048 m, 27.561667N, 97.108695E, 27.X.2014, *J. Kluge & P. K. Kine 14-054-001d-A* (DR, private herbarium Bruggeman-Nannenga).

REMARKS

The taxon was described as *Fissidens obscuriretis* Broth. & Paris from New Caledonia (Brotherus 1909) and was later transferred to the rank of a variety of *F. linearis* Brid. by Stone (1991).

The taxa has previously been reported from Australia (e.g. Stone 1991; Cairns *et al.* 2019), China (Li 1985; Redfearn *et al.* 1996), Fiji (Iwatsuki & Suzuki 1996), Korea (Li & Iwatsuki 2001), Japan (Iwatsuki 1991), New Caledonia (type), Taiwan (Li & Iwatsuki 2001), New Hebrides, Vanuatu (Iwatsuki & Suzuki 1995), Papua New Guinea (Suzuki & Iwatsuki 2011), and Philippines (Tan & Iwatsuki 1991).

A record from India (Manjula *et al.* 2015) seems to be *Fissidens speluncae* Herzog.

Fissidens pokhrensii Nork. ex S.S.Kumar

SPECIMENS EXAMINED. — Myanmar, Kachin State, Hponkan Razi, epiphytic in evergreen broadleaved forest, mixed with *F. serratus* and *F. strictidens*, 1565 m, 27.548702N, 97.032742E, 14.X.2014, *J. Kluge & P. K. Kine 14-031-001b-B2* (DR, private herbarium Bruggeman-Nannenga); Natma Taung (Mt Victoria), epiphytic in evergreen Oak forest, 2000 m, 21.2034963N, 94.0236152E, 10.XI.2012, *P. K. Kine 12_74_09-F* (DR, private herbarium Bruggeman-Nannenga).

REMARKS

The species was described by Kumar (1979) from India (Himachal-Pradesh) and was reported as new to Japan (Honshu) by Suzuki (2017). *Fissidens pokhrensii* belongs to sect. *Semilimbidium* Müll.Hal. and is characterized by narrowly lanceolate leaves, a yellow costa ceasing below the apex, pluripapillose laminal cells and smooth setae.

Fissidens serratus Müll.Hal.

SPECIMEN EXAMINED. — Myanmar, Kachin State, Hponkan Razi, epiphytic in evergreen broadleaved forest, mixed with *F. pokhrensii* and *F. strictidens*, 1565 m, 27.548702N, 97.032742E, 14.X.2014, *J. Kluge & P. K. Kine 14-031-001b-B1* (DR, L).

REMARKS

A pantropical species, widely distributed in SE Asia.

Fissidens wichurae Broth. & M.Fleisch.

SPECIMEN EXAMINED. — Myanmar, Natma Taung (Mt Victoria), epiphytic in evergreen Oak forest with Taungya succession, 1400 m, 21.2194427N, 94.0699586E, 25.X.2012, *P. K. Kine 12_46_11-C1* (DR, private herbarium Bruggeman-Nannenga).

REMARKS

A species widely distributed in tropical and subtropical regions of Asia (China, Indonesia, Malaysia, New Guinea, Japan, Philippines) (Li & Iwatsuki 2001; Linis 2009; Suzuki & Iwatsuki 2012).

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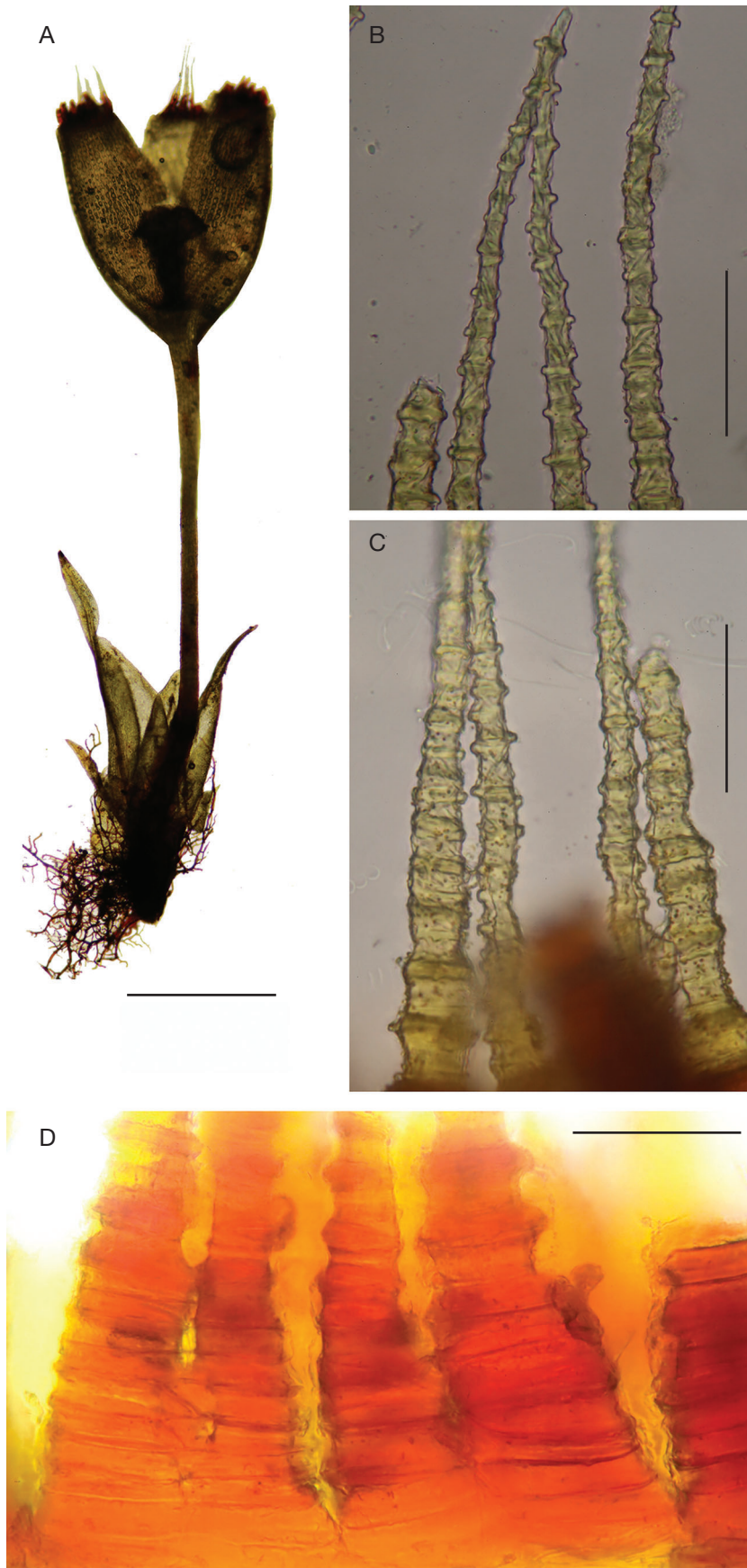


FIG. 5. — *Fissidens pseudoanomalus* sp. nov.: **A**, sporophyte; **B**, upper part of peristome teeth; **C**, median part of peristome teeth; **D**, exterior side of basal part of peristome teeth. A-D from holotype Miehle et al. 13-076-075-F. Scale bars: A, 1 mm; B-D, 50 µm.

checked his specimens of *Fissidens anomalus* and *F. dubius* from Yunnan and the Philippines and has given us information on their characters. We thank Jessica E. Beever and an anonymous reviewer for their helpful suggestions.

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