



New combinations and a key to the species of *Pelekium* (Thuidiaceae) in sub-Saharan Africa and the East African Islands

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Abstract

Two taxa currently recognised in *Thuidium* are transferred to *Pelekium* to complete the relocation of monoicous species from *Thuidium* subg. *Microthuidium* to *Pelekium*. The new combinations are: *Pelekium thomeanum* (Broth.) Phephu *stat. et comb. nov.* (basionym *Thuidium involvens* (Hedw.) Mitt. var. *thomeanum* Broth.), now recognised as a species distinct from *P. involvens* (Hedw.) A. Touw, and *P. pseudoinvolvens* (Müll. Hal.) Phephu *comb. nov.* A full taxonomic treatment, including descriptions and notes on the distribution and ecology of these two species is presented, followed by a key to the African species of *Pelekium*.

Key words: Africa, classification, nomenclature, *Thuidium*, taxonomy

Introduction

While revising the African members of Thuidiaceae, two African endemics currently recognised in the genus *Thuidium* Bruch & Schimp., *T. involvens* (Hedw.) Mitt. subsp. *thomeanum* Touw and *T. pseudoinvolvens* (Müll. Hal.) A. Jaeger, were found to display characters typical of the genus *Pelekium*. When Touw (2001) transferred almost all monoicous species previously treated in *Thuidium* subg. *Microthuidium* to the genus *Pelekium* Mitt., he did not transfer these two taxa, as well as a number of other (mainly South American) species, either because he had not yet examined type specimens or because he was not convinced that they were 'good' taxa (Touw, pers comm., 2010). We have now examined the African taxa in detail and decided to move them to *Pelekium* as well.

Pelekium is distinguished from the other two genera of Thuidiaceae in Africa, *Thuidium* and *Thuidiopsis*, by its small size, simple or weakly branched paraphyllia, plane or weakly plicate stem leaves, occasionally ornamented seta and monoicous sexual state. This is the largest and the most morphologically and ecologically diverse genus of African Thuidiaceae. A key to the 12 species of *Pelekium* recognized in Africa, now including *P. thomeanum* and *P. pseudoinvolvens*, is given below.

Taxonomic treatment

Pelekium thomeanum (Broth.) Phephu *stat. et comb. nov.*

Basionym:—*Thuidium involvens* (Hedw.) Mitt. var. *thomeanum* Broth. (1890: 183).

Other combinations:—*Thuidium involvens* subsp. *thomeanum* (Broth.) A. Touw (1976: 168).

Cyrto-hypnum involvens subsp. *thomeanum* (Broth.) W.R.Buck & H.A.Crum (1990: 65).

Type:—SAO TOMÉ. Queluz: 270 m, *Quintas 1333a* (holotype H, fide Touw (1976)).

Description:—*Plants* medium-sized, pale green to yellowish green or brownish. *Stems* to 60 mm long, arching, 1 or 2-pinnately branched. *Paraphyllia* many, simple to very weakly branched, short, mixed with long ones, to 15 cells long; cells oblong-rectangular or isodiametrical, sparingly papillose; terminal cell truncate, papillose. *Axillary hairs* with 1 brown basal and 1 or 2 hyaline apical cells. *Branches* to 5 mm long, closely to remotely set; paraphyllia very few to lacking on branchlets. *Leaves* dimorphic, strongly incurved. *Stem leaves* 0.5–10 mm long, 0.25–0.6 mm wide, narrowly to broadly cordate-triangular, with patent base, plain to weakly plicate, closely set; when dry crisped, curved, concave, when wet spreading to widely patent. *Apex* gradually or abruptly short- to mostly long-acuminate, often twisted when dry. *Costa* strong, percurrent, ending in apex, tip indistinct, abaxially prominent, often grooved; cells smooth to very weakly papillose. *Margins* recurved to rarely plane below, plane upwards, papillate-crenulate. *Terminal laminal cell* truncate. *Median cells* 7–12 × 5–10 µm, short- to elongate-rhomboidal or -hexagonal, mainly unipapillose, some cells bi- to pluripapillose especially towards base; papillae weak or prominent, mostly central on lumen; cell walls thick or thin. *Basal cells* longer, larger, sometimes yellowish and smooth at insertion. *Alar cells* not differentiated. *Branch leaves* to 0.75 mm long, broadly rounded at base to narrowly ovate, asymmetrical, when dry strongly incurved, crisped, chain-like, with twisted apex and patent base, when wet spreading, complanate. *Apex* abruptly acute to short-acuminate. *Margins* recurved below, plane upwards, papillate-crenulate. *Costa* strong, abaxially weakly prominent, occasionally protruding in a distal spine. *Terminal laminal cell* truncate. *Laminal cells* to 6 µm wide, isodiametrical, mostly unipapillose, pluripapillose towards base, papillae low, indistinct.

Autoicous. *Perigonia* about 0.9 mm long; leaves ovate to broadly lanceolate; apex acute to abruptly long-acuminate; costa strong to weak; entire to weakly serrate; cells isodiametrical, smooth, thick-walled; cells at insertion yellowish brown. *Perichaetial inner leaves* to 2 mm long; apex abruptly filiform, ending in subula; costa strong, filling subula; margins entire to serrulate, shoulders eciliate. *Setae* to 17 mm long, strongly roughened throughout, reddish. *Capsules* 0.6–1.5 mm long, ovoid to elliptic, weakly curved, horizontal to pendulous, constricted at neck, reddish brown. *Exothecial cells* quadrate, smooth; walls incrassate, collenchymatous. *Peristome* perfect; exostome teeth oblong-lanceolate, cross-striate below, papillose and trabeculate upwards, yellowish brown below, hyaline upwards; endostome membrane ½ the length of exostome; processes keeled (or carinate), narrowly perforate; endostome cilia in groups of 3, free. *Operculum* 1.0 mm long, long-rostrate. *Calyptrae* 1.5–1.7 mm long, cucullate, apex obtuse, smooth. *Spores* about 10–13 µm in diameter, papillose.

Diagnostic characters:—The species is recognised by 1-pinnately branched stems, simple to weakly branched, short or long paraphyllia with a truncate terminal cell, plain to weakly plicate stem leaves with gradually or abruptly acuminate short to long-acuminate apex, truncate terminal cell and unipapillose median cells, truncate branch leaf terminal cell, strongly roughened seta and eciliate inner perichaetial leaf shoulders.

Ecology and distribution:—*Pelekium thomeanum* is a lowland, forest bottom species growing in the rain forest zone or high forests, on tree bases, decaying wood, or occasionally terrestrial on soil and rocks, at 270–900 m, in light to dense shade. *P. thomeanum* is endemic to Africa and occurs in Angola, Cameroon, Central African Republic, Côte d'Ivoire, Congo, Equatorial Guinea (Río Muni), Democratic Republic of Congo, Gabon, Ghana, Nigeria, Togo, and São Tomé. The lowland tropical American variant of *P. involvens*, namely *P. involvens* var. *involvens*, is known from Florida, Mexico, Ecuador, Bolivia, Venezuela and Brazil.

Specimens of *P. thomeanum* examined:—DEMOCRATIC REPUBLIC OF CONGO: Müller Z331 (L). CAMEROON: *Argent AR.522* (BM); *Dusen s.n.* (NY); *Sjostedt s.n.* (NY); *Staudt 711* (BM); *Zenker 2008b* (BM). NIGERIA: *Barter 1424*; (BM). ANGOLA: *Junio 174* (BM). TANZANIA: *Pócs & Pócs 6236/H* (EGR).

Specimens of *P. involvens* examined:—DOMINICAN REPUBLIC: *Allard 16142, 16168, 16209a, 17923a, 17958*, (NY); *Buck 4966, 4969, 5066, 5118* (NY); *Reese 15051, 15496, 15560* (NY).

Notes:—Brotherus (1890) created an African variety ‘*thomeanum*’ of the American *Thuidium involvens* based on a *Quintus 1333a* specimen collected in São Tomé. Touw (1976) changed that variety to subspecies rank as *Thuidium involvens* subsp. *thomeanum*. Although Touw (1976) regarded the American and African taxa as forms of a single species with many plants showing intermediate characters, he ranked the African taxon as a subspecies because of its geographical isolation. He recently suggested that more American material be examined to decide the rank at which ‘*thomeanum*’ should be recognized (Touw, pers comm., 2010). In his notes, O’Shea (2006) suggested that the subspecies, like *P. involvens*, presumably belongs to *Pelekium*. We found that *Thuidium involvens* subsp. *thomeanum* resembles other medium- and small-sized species of *Pelekium* like *P. varians* (Welw. & Duby) Touw, *P. chenagonii* (Müll. Hal. ex Renauld & Cardot) Touw, *P. ramusculosum* (Mitt.) Touw and *P. velatum* Mitt. It resembles *P. varians* in many respects especially in the 1-pinnate branching. It is similar to *P. velatum* on account of eciliate perichaetial leaf shoulder margins and small spores.

The American *P. involvens* var. *involvens* and var. *thomeanum* are similar in respect to the 1-pinnately branching, strongly incurved stem leaves with long-acuminate apex, eciliate inner perichaetial leaf shoulder margins, and rough setae of equal lengths.

However the African plants differ from the American *P. involvens* in the latter having slightly shorter stems, shorter and unbranched paraphyllia, smaller stem and branch leaves, blunt branch leaf apex, plane stem leaves with entire margins and pluripapillose laminal cells, a slightly longer capsule, narrower and more curved when dry, and smaller spores.

Pelekium pseudoinvolvens (Müll. Hal.) Phephu *comb. nov.*

Basionym:—*Hypnum pseudoinvolvens* Müll. Hal. (1876: 285).

Other combination:—*Thuidium pseudoinvolvens* A. Jaeger (1878: 254).

Type:—COMOROS. Johanna: Anjouan, ad truncos arborum, 800 m, *Hildebrandt 1835* (holotype B, lost; lectotype G, isolectotypes K, NY, fide Touw (1976); BM!).

Description:—*Plants* medium-sized; yellow- or dark-green. *Stems* prostrate, about 55 mm long; 2-pinnately branched. *Paraphyllia* few, scattered to dense, mostly short, or long, to 11 cells long, mostly simple to moderately branched; cells mostly rectangular, smooth to papillose; terminal cell truncate, papillose. *Axillary hairs* of 1 hyaline basal and 2 brown apical cells. *Branches* to 5 mm long, remote, sparingly pinnate; branchlets remote and irregular; paraphyllia few basally to absent upwards, lacking on branchlets. *Leaves* dimorphic. *Stem leaves* distant, 0.4–0.6 mm long, 0.2–0.3 mm wide, triangular to subtriangular, plane to weakly plicate; when dry incurved, weakly spreading, appressed with long, incurved, flexuose or twisted apex; when wet erect spreading, concave, basally paraphyllate, short decurrent. *Apex* gradually narrowly short- to long-acuminate. *Costa* strong; percurrent, ending in apex, tip indistinct, abaxially prominent when dry, weakly so when moist. *Margins* irregularly plane or recurved, papillate-crenulate, bordered by a row of shorter or oblate cells. *Terminal laminal cell* truncate, occasionally acute papillose or smooth. *Upper cells* short to elongate, pluripapillose to smooth. *Median cells* 10–17 × 6 µm, short to long, variously angled hexagonal-rhomboidal, pluripapillose, 1 or 2 or rarely 3 papillae over lumina, papillae low or sharp, small, thin- to thick-walled. *Basal cells* larger, longer, smooth to pluripapillose; papillae low and blunt. *Alar cells* not differentiated. *Branch leaves* to 0.45 mm long, lanceolate, asymmetrical, when dry with spreading base and strongly incurved-twisted apex, when wet spreading to complanate. *Apex* acute to short-acuminate. *Margins* mostly plane to occasionally recurved, papillate-crenulate. *Costa* percurrent, tip distinct; abaxially prominent when dry, weakly or not when moist. *Terminal laminal cell* truncate and often larger than adjacent cells. *Laminal cells* to 6 µm wide; short, variously angled or hexagonal, pluripapillose, papillae low, blunt, indistinct, crowded; walls incrassate. *Basal cells* larger, longer, pluripapillose to smooth.

Autoicous. Perigonia 0.5–1.0 mm long; leaves linear-lanceolate; apex mostly gradually filiform; margins plane or recurved, entire, serrate or papillose-crenulate; costa weak, percurrent; cells elongate-hexagonal or

-rhombic, smooth to mostly papillose, thin-walled. *Perichaetial inner leaves* to 1 mm long, oblong-lanceolate; apex mostly gradually to abruptly subulate, erect or flexuose; margins plane, entire or weakly serrate, shoulders ciliate; cells linear-rhomboidal or rectangular, smooth or weakly unipapillose. *Setae* 6–8 mm long; strongly roughened throughout, brown. *Capsules* 0.5–0.7 mm long, ovoid, subpendulous, dark brown. *Exothecial cells* isodiametrical, quadrate or rounded, smooth; walls incrassate, collenchymatous. *Peristome* perfect; exostome teeth oblong-lanceolate, cross-striate and short-trabeculate below, becoming papillose, trabeculate and hyaline upwards; endostome shorter than exostome; membrane ½ the length of processes; processes weakly keeled, narrowly perforate upwards; endostome cilia in groups of 2 or 3, free. *Operculum* 1 mm long, short-rostrate, dark brown. *Calyptra* cucullate, smooth; apex acute, gradually mucronate. *Spores* 7–15 µm in diameter, papillose.

Diagnostic characters:—The species is recognised by the remotely 2-pinnately branched stems, short or long, simple to weakly branched paraphyllia with a truncate terminal cell, plane to weakly plicate stem leaves with gradually short to long-acuminate apex, truncate terminal laminal cell and uni- to bipapillose median cells, truncate branch leaf terminal cell, strongly roughened seta and ciliate inner perichaetial leaf shoulders.

Ecology and distribution:—*Pelekium pseudoinvolvens* is an epiphytic, lowland rain forest species growing on dead wood or tree trunks, at 450–800 m. It is endemic to Africa and has an East African islands distribution (Comoro, Mauritius, Madagascar and Mayotte). It is also reported to occur in Tanzania (O’Shea, 2006).

Notes:—After having studied the tropical Asian members of *Pelekium*, Touw (pers comm., 2010) questioned if *P. pseudoinvolvens* is really different from *P. gratum* (P. Beauv.) Touw. Although *P. pseudoinvolvens* is closely related to and sympatric with *P. gratum*, it differs from it in the weak, remotely bi-pinnate branching, stem paraphyllia less dense, paraphyllia cells longer and less papillose, often plane stem leaves with median and especially apical laminal cells elongated with thinner walls, papillae often less prominent, calyptra apex gradually mucronate, and exostome teeth broader and taller. These two species are similar in size, median cell ornamentation, inner perichaetial leaf shoulder margin and seta ornamentation. For consistency in the family, *P. pseudoinvolvens*, like the other small thuidioid species, should be classified under *Pelekium* as circumscribed by Touw (2001), where it is closely related to species like *P. gratum*.

Specimens examined:—MADAGASCAR: *Marie s.n.* (BM). COMOROS: *Hildebrandt 1835* (BM). MAYOTTE: *Marie 64, 85, 103, s.n.* (BM). MAURITIUS: *Robillard s.n.* (BM).

Key to the species of *Pelekium* Mitt. in Africa

1. Plants mostly minute to small (stems ≤ 50 mm long); paraphyllia simple, short (usually ≤ 7 cells long) 8
- Plants medium-sized (stems > 50 mm long); paraphyllia simple to weakly branched, short or long (usually ≥ 8 cells long) 2
2. Terminal cells of paraphyllia and stem leaves predominantly acute *P. ramusculosum*
- Paraphyllia and stem leaf terminal cell mostly truncate 3
3. Stem leaves mostly not plicate; margins plane; apex broadly acute *P. varians*
- Stem leaves plane to weakly plicate; margins recurved below, plane above; apex acute, acuminate or apiculate 4
4. Stem leaf apex long apiculate; seta strongly hispid *P. velatum*
- Stem leaf apex acute or acuminate; seta smooth or roughened throughout 5
5. Stems 2- or 3-pinnately branched; laminal cells uni- or bipapillose; perichaetial leaf shoulders ciliate; seta smooth ..
..... *P. chenagonii*
- Stems 1- or 2-pinnately branched; laminal cells uni- to pluripapillose; perichaetial leaf shoulders ciliate or eciliate; seta roughened throughout 6
6. Stems 1- or 2-pinnately branched; laminal cells mostly unipapillose, mixed with bi- to pluripapillose ones; perichaetial leaf shoulders eciliate *P. thomeanum*
- Stems 2-pinnately branched; laminal cells bi- to pluripapillose; perichaetial leaf shoulders ciliate 7
7. Paraphyllia few, mostly simple; stem leaves plane to weakly plicate *P. pseudoinvolvens*
- Paraphyllia abundant, mostly weakly branched; stem leaves mostly plane *P. gratum*
8. Plants wiry; stems irregularly branched; paraphyllia almost absent; stem leaf cells thin-walled *P. investe*

- Plants not wiry; stems regularly branched; paraphyllia abundant; stem leaf cells thick-walled 9
- 9. Stems 2-pinnately branched; paraphyllia simple, short; laminal cells with 1–3 papillae; perichaetial leaf shoulders eciliate; seta rough at neck *P. versicolor*
- Stems 1-, 2-, or 3-pinnately branched; paraphyllia simple to weakly branched; laminal cells with 1 or 2 papillae; perichaetial leaf shoulders ciliate or not; seta smooth or rough at neck 10
- 10. Stems (1–)2(–3)-pinnately branched; paraphyllia abundant; perichaetial leaf shoulder eciliate; seta rough at neck.....
..... *P. contortulum*
- Stems (1–)2-pinnately branched; paraphyllia few perichaetial leaf shoulders ciliate or not; seta smooth or rough at neck 11
- 11. Paraphyllia simple to weakly branched; stem leaves plane to weakly plicate; laminal cells uni- or bipapillose; perichaetial leaf shoulders eciliate; seta smooth *P. intricatum*
- Paraphyllia simple; stem leaves plane; laminal cells unipapillose; perichaetial leaf shoulders ciliate; seta rough at neck *P. minusculum*

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