

Acaulonopsis, a new moss genus of the Pottiaceae from Western Cape Province of South Africa, and comments on *Vrolijkheidia*

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SUMMARY

A new genus, *Acaulonopsis* (Pottiaceae, Bryophyta), including two new species, *A. fynbosensis* and *A. eureka*, is described from the Western Cape Province of South Africa. Together with the similarly much reduced pottiaceous genus *Acaulon*, *Acaulonopsis* is unique in the family with a very short seta and spherical capsule, which lacks the apiculus found in other genera. The new genus is also distinguished by short plant stature, and a total of about five ovate leaves that clasp closely the capsules in nearly spherical leaf bases. Continuing bryological study of the fynbos region has recently resulted in a number of startling discoveries of bryophytes new to science and distinct at the genus level. A new combination is made for the South African endemic genus *Vrolijkheidia* (Pottiaceae) with discussion of its dimorphic habitus.

KEYWORDS: *Acaulonopsis*, *Vrolijkheidia*, Pottiaceae, fynbos, Cape Province, South Africa

Acaulonopsis R. H. Zander & Hedd., gen. nov.

Type species: *Acaulonopsis fynbosensis* R. H. Zander & Hedd.

Plantae adpersae vel gregariae vel caespitem laxum formantes, rufae. Caules brevissimi, pilis axillaribus ex cellulis 1–4 et basalibus 1–2 interdum brunneolis compositis; rhizoideis transparentibus abundantibus. Folia 5–6, late ovata vel deltoidea, apice plerumque acute reflexo, vulgo concava vel supra canaliculata, in dimidio inferiore saepe saccata, marginibus foliaribus planis vel in dimidio superiore recurvis, integris vel leniter prope apicem denticulatis, elimbata vel limbo e cellulis prope apicem folii 1–3 angustioribus parietibus crassioribus minus papillois, costa in apicem acutum validum vel in cellulam unicam laevem breviter excurrenti, utrinque papillosa interdum dorsaliter prorulosa, cellulis superficialibus utrinque breviter rectangularibus vel elongatis, sectione transversali rotundata, epidermide utrinque praesenti, strato stereidarum unico, cellulis ducum ut videtur non distinctis, funiculo hydroideo interdum praesenti, cellulis laminalibus superioribus subquadratis vel breviter rectangularibus vel rhombiformibus, interdum irregularibus, maximam partem latitudine 10–16 μm , 1–1.5:1, parietibus aequae incrassatis, in sectione transversali in ambabus superficiebus liberis aequae incrassatis, papillis simplicibus vel bifidis cellulis basalibus valde distinctis hyalinis, secus marginem elimbatis, 3–6:1, ad

insertionem in seriebus transversalibus unistratosis. Synoicae, paroicae vel rhizautoicae. Perichaetia terminalia, foliis interioribus leniter quam caulinis maioribus, saepe proxime super basem saccatum constrictis. Seta brevissima, hyalina, recta vel curva, subtilis faciliter rupta. Capsula cleistocarpica, sphaerica, 0.25–0.35 mm diametro, brunnea vel fusco-brunnea, cellulis exothecialibus quadratis vel rhombiformibus vel interdum brevi-rectangularibus, parietibus tenuibus, stomatibus paucis, phaneroporis, ad basem capsulae extremum sitis. Vaginula ca 1/4–1/2 amplitudinis capsularis. Calyptra exigua, brevi-conica. Sporae complanatae, ellipsoideae, flavo-brunneae, 20–25 \times 12–20 μm , paene laeves vel papillosae. Lamina folii KOH ope rubra.

Plants terricolous, scattered to gregarious or forming a loose turf, reddish. *Stems* simple and very short, in section round, of thin-walled homogeneous cells; axillary hairs of 1–4 cells with 1–2 basal cells sometimes brownish; transparent rhizoids abundant on obtuse base of stem. *Leaves* few, 5–6, erect when dry, weakly spreading when moist, broadly ovate to deltoid, apex usually sharply reflexed, usually concave or channeled above, clasping and often saccate in lower half; leaf margins plane to recurved in upper half, entire or weakly denticulate near apex, border not differentiated or of 1–3 narrower, thicker-walled and less papillose cells near leaf apex; costa short-excurrent as

sharp stout apiculus or single smooth cell, 25–50 μm in width just above midleaf, papillose on both sides, occasionally also prorulose dorsally with distally protruding cell ends, superficial cells short-rectangular to elongate on both sides, transverse section rounded, epidermis present on both sides, one stereid band, guide cells apparently not differentiated, hydroid strand occasionally present; upper and medial laminal cells subquadrate to short-rectangular or rhombic, occasionally irregular, mostly 10–16 μm in width, 1–1.5:1, walls evenly thickened, in section equally thickened on both free surfaces, papillae simple to bifid, 2–4 per cell on each free side; basal cells strongly differentiated in lower half of leaf, hyaline, not bordered along margins, 12–20 μm wide, 3–6:1, unistratose at insertion. *Sexual condition* synoicous or rhizautoicous. *Perichaetia* terminal, inner leaves intergrading with cauline leaves but slightly larger, often constricted just above saccate base. *Seta* short, nearly absent or to 0.02 mm, hyaline, straight or curved, delicate and easily broken. *Capsule* cleistocarpic, immersed in perichaetial leaves, spheric, 0.25–0.35 mm in diameter, brown or yellow-brown, exothecial cells quadrate to rhombic or occasionally short-rectangular, 25–40 μm wide, thin-walled; stomata few, phaneropore, on extreme base of capsule. *Vaginula* ca 1/4–1/2 the size of the capsule. *Calyptra* small, hyaline except for brownish tip, short-conic. *Spores* flattened ellipsoidal, yellow-brown, 20–25 \times 12–20 μm , nearly smooth or papillose. *Laminal KOH colour reaction* red.

The two species described here do not appear in previous treatments of the South African moss flora, particularly the recent summary of Magill (1981). Salient traits distinguishing *Acaulonopsis* from all other miniscule Pottiaceae except *Acaulon* Müll. Hal. are the spherical, cleistocarpic capsules lacking an apiculus, and from *Acaulon* by the laminal cells papillose, with both free surface walls in section equally thick-walled. *Acaulon* is similar, but has plane upper leaf margins, leaves not constricted medially above a saccate base (the whole leaf concave and sheathing the capsule), costa with weak stereid band, laminal cells usually rectangular and very thin-walled, smooth, thickened more strongly on the dorsal free surface, and seta light brown (see also key below). *Acaulon uleanum* Müll. Hal., of Brazil, has thick-walled upper laminal cells, but otherwise matches *Acaulon* well. The presence of an apiculus in cleistocarpic capsules of other genera is a long-recognized highly conservative trait (Zander, 1993).

Taxa that are much reduced in stature and expression of traits are commonly difficult to assign affinities, but the leaves of the new genus have a majority of the significant traits of *Syntrichia* Brid. This last genus is known to have no member with reduced sporophytes (Zander, 1993), unlike the KOH-yellow reacting *Tortula*, but the likewise Southern Hemisphere *Willia* Müll. Hal., with its stegocarpic capsule on a short seta, appears to be an intermediate taxon. That major gaps exist between these three KOH-red reacting taxa, and also between genera with similarly papillose ovate leaves like *Chenia* R. H. Zander, *Hilpertia*

R. H. Zander, *Microbryum* Schimp., and *Stonea* R. H. Zander, indicate that considerable geologic time has passed during which considerable evolutionary experimentation and selection has isolated these groups.

1. Leaf margins recurved in upper portion, commonly weakly bordered with narrow, somewhat thicker-walled cells near apex; costa narrow above midleaf, mostly 25–35 μm wide, weakly papillose; synoicous or paroicous; seta short but distinct, 0.10–0.20 mm; spores spiculose-papillose ... *Acaulonopsis fynbosensis*
2. Leaf margins mostly plane, sometimes weakly recurved above, unbordered; costa broad above midleaf, mostly 40–50 μm in width, strongly papillose; rhizautoicous; seta extremely short or nearly absent, 0.015–0.040 mm; spores smooth or weakly low-papillose... *Acaulonopsis eureka*

Acaulonopsis fynbosensis R.H. Zander & Hedd., **sp. nov.** (Fig. 1)

Basis foliaris in foliis superioribus adliganti-saccata; margines folii in portione superiore recurvae, vulgo leniter prope apicem e cellulis angustis limbatae; costa in apiculum validum acutum laevem rubrum excurrens, in parte mediana angusta, plerumque 25–35 μm lata, leniter papillosa; plantae synoicae vel paroicae; seta 0.10–0.14 mm longa.

Plants reddish green to brown. *Stems* 0.1–0.2 mm, axillary hairs of 3–4 rectangular cells with basal 1–2 cells thicker-walled. *Leaves* not contorted and loosely folded along the midline when dry, erect to erect-spreading when wet, broadly ovate and concave or broadly channeled, strongly reflexed apically, 0.8–1.1 mm long, grading insensibly into perichaetial leaves with upper lamina concave to short-tubulose weakly constricted above clasping-saccate base; leaf margins weakly to strongly recurved from midleaf to near apex, entire or weakly denticulate near apex, border of 1–3 narrower, thicker-walled and less papillose cells often weakly differentiated near apex; costa excurrent as stout, sharp, smooth, red, reflexed apiculus, mostly 25–35(–50) μm in width, superficial cells of costa elongate and papillose with hemispheric papillae dorsally, short-rectangular and scattered papillose ventrally, transverse section round, with one strong circular to flattened-oval stereid band (guide cells apparently 2 in a single layer, commonly thick-walled and except for position indistinguishable from stereid cells), hydroid strand usually present in thicker portions of costa; upper and medial laminal cells subquadrate to short-rectangular, (11–)13–18 μm long \times 10–13(–15) μm wide, papillae solid or occasionally hollow, simple to bifid, 2–4 per cell; basal cells 12–15 μm wide, 3–5:1. *Sexual condition* synoicous and paroicous. *Perichaetia* with inner leaves to 1.2 mm long, broadly ovate to ovate-deltoid, commonly constricted just above broadly sheathing base, differentiated thin-walled basal cells extending 2/3 way or more up leaf. *Sporophytes* 1(–2) per perichaetium. *Seta* short, 0.10–0.20 mm long, hyaline, straight or curved, delicate and easily broken. *Capsule* spheric, 0.30–0.35 mm in diameter, yellow-brown, exothecial cells quadrate to

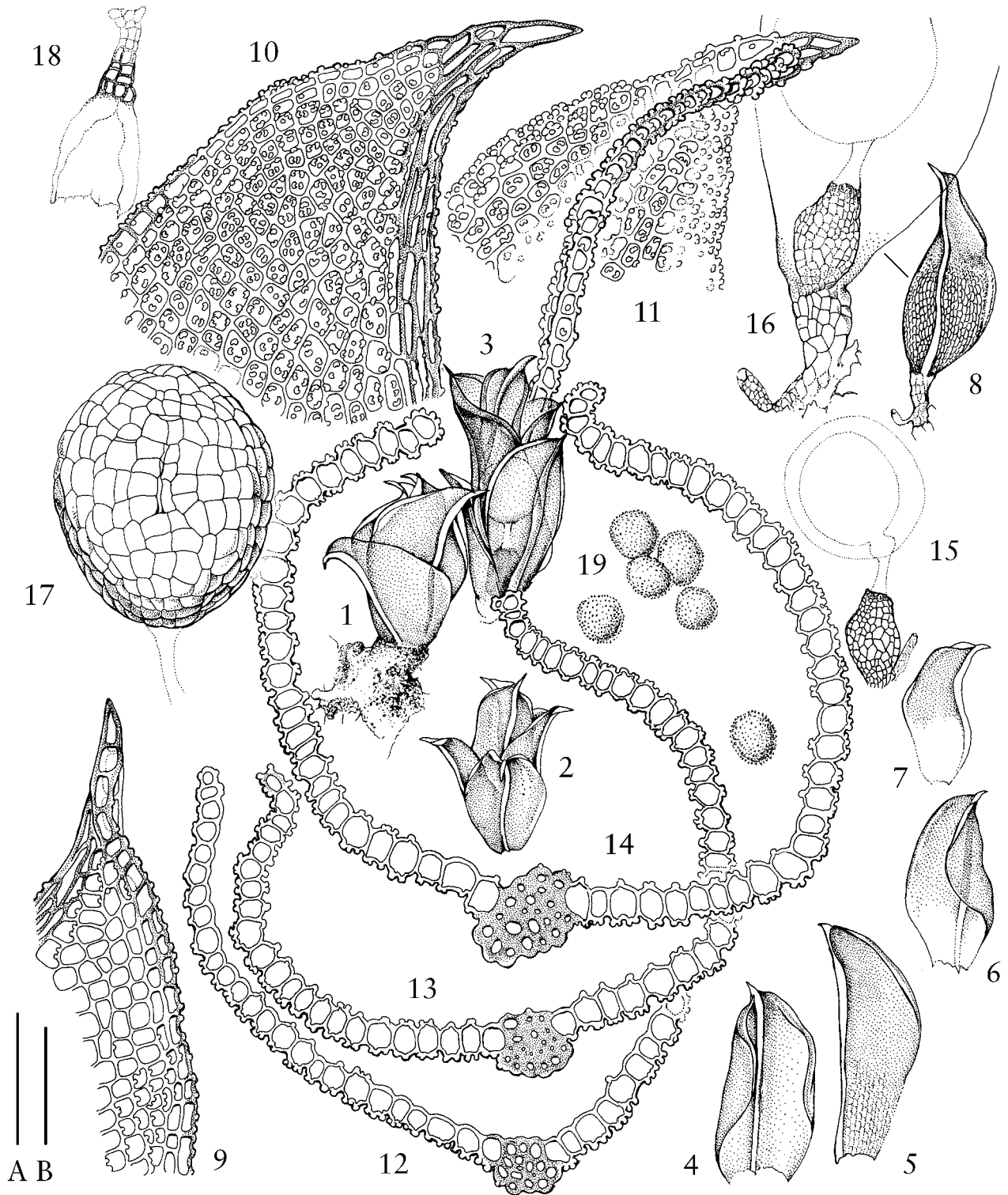


Figure 1. *Acaulonopsis fynbosensis*. 1–2, habits, vegetative; 3, habit, fertile; 4–7, leaves; 8, perichaetial leaf; 9–11, leaf apices; 12, transverse section near leaf base; 13–14, transverse sections in upper half of leaf; 15–16, vaginulae and antheridia; 17, capsule; 18, calyptra; 19, spores. Scale bars: A=1 mm, 1–7; B=50 µm, 8–19

rhombic, 30–40 µm wide. *Vaginula* nearly half the size of capsule, ca 150 µm in length. *Calyptra* ca 0.06 mm long, quickly lost. *Spores* 20–23 × 12–15 µm, spiculose-papillose.

Derivation of the epithet: fynbos, or 'fine bush' in Afrikaans, is the shrubland vegetation found in

Mediterranean-climate (winter-wet, summer-dry) coastal and mountainous areas of the Western Cape of South Africa.

Type: South Africa, Western Cape Province, Oliphants River Mountains, Porterville Area, Beaverlac, T. A. J.

Hedderson 16061 (holotype BOL, isotype MO). Paratypes: T. A. J. Hedderson 16049, 16057a (BOL, MO).

Acaulonopsis eureka R.H. Zander & Hedd., sp. nov. (Fig. 2)

Basis foliaris late canaliculata vel concava; margines folii planae, elimbatae; costa breviter in apiculum acutum e cellula unica laevi excurrens, in parte mediana plerumque 40–50 μm lata, valde papillosa, interdum dorsaliter prurulosa; plantae rhizautoicae; seta brevissima vel paene absens.

Plants reddish green. Stems ca 0.10 mm; axillary hairs of 1(–2) rectangular hyaline cells, rare. Leaves not or weakly contorted and channeled when dry, weakly-spreading when wet, ovate and concave or broadly channeled, strongly to weakly reflexed or straight apically, 0.6–1.1(–1.4) mm long, grading insensibly into perichaetial leaves, upper lamina broadly concave to channeled only along costa; leaf margins mostly plane but often recurved near apex, entire (although crenulate by strong papillae), marginal cells not differentiated; costa short-excurrent as a sharp apiculus of one smooth cell, mostly 40–50(–55) μm wide, dorsal superficial cells of costa elongate and densely papillose with simple to bifid papillae, and often also prurulose by projecting cell ends, short-rectangular to rhombic and densely papillose ventrally, transverse section round, one stereid band evident, strong, circular, guide cells apparently absent, hydroid strand apparently absent; upper and medial laminal cells subquadrate or irregular (10–13)–16 μm , papillae solid or occasionally hollow, simple to bifid, 2–4 per cell; basal cells 12–20 μm wide, 3–6:1. Sexual condition rhizautoicous by small 2–3 leaved male buds buried in rhizoid mass at base of perichaetial plants. Perichaetia with inner leaves to 1.4 mm long, broadly ovate, occasionally constricted just above broadly sheathing or bulging-spheric base, differentiated thin-walled basal cells extending 2/3 way or more up leaf. Sporophytes 1(–2) per perichaetium. Seta very short or nearly absent, 0.015–0.040 mm long, hyaline, straight, delicate and easily broken. Capsule spheric or very short-oval, 0.25–0.30 mm in diameter, brown, exothecial cells quadrate to rhombic, or occasionally short-rectangular, 25–30 μm wide, 1(–2):1. Vaginula ca 1/4 size of the capsule, ca 100–120 μm in length. Calyptra small, ca 0.14 mm long. Spores 20–25 \times 17–20 μm , smooth or weakly low-papillose.

Derivation of the epithet: eureka expresses joy in discovery. It is an English word, ultimately from hēurēka, 'I have found it!' being the first person singular perfect indicative active of the Greek verb heuriskein. It alludes to realizing after much puzzlement that there was not one but two new species among the studied material of this new South African genus. The epithet is not declined.

Type: South Africa, Western Cape Province, Groot Winterhoek Nature Reserve, path from Tulbagh to Sneeuat, shale slope with sandstone boulders and fynbos, about half way along trail, ca 720 m, 33°09'30"S, 19°10'01"E, T. A. J. Hedderson 14241 (holotype–BOL, isotype–MO).

DISCUSSION

Sexing these species is difficult because the antheridia are uncommon, small, easily dislodged. Their cells walls are much thinner than other areolation, which affords, however, one means of quick identification. The sexuality of *A. eureka* is not perfectly clear as in one instance the inflorescence appeared synoicous, with one antheridium associated with the vaginula but loose, but three definitely rhizautoicous buds were also seen. The situation with *A. fynbosensis* is variable, with one gynoeceum definitely synoicous, but two others apparently paroicous. With more material of these tiny, refractory mosses available, variation in sexuality could be more accurately determined.

Other than *Acaulon* and *Acaulonopsis*, cleistocarpic mosses have an apiculus on the capsule, excepting aberrant cases such as reported for a collection of *Pterygoneurum subsessile* (Brid.) Jur. by Pisarenko (2006).

Recent floristic work in South Africa has resulted in description of five new taxa, four as new genera, in the Pottiaceae: *Algaria nataliae* Hedd. & R. H. Zander [as 'nataliei'], *Chenia ruigtevleia* Hedd. & R. H. Zander, *Ludorughya springbokorum* Hedd. & R. H. Zander, *Triquetrella mxinwana* Hedd. & R.H. Zander, and *Vrolijkheidia circumscissa* Hedd. & R. H. Zander (Hedderson & Zander, 2007a, b, 2008a, b, c). Although we have found an earlier specific epithet for *Vrolijkheidia* (see below), this implies that, in spite of decades of bryological field investigation, South Africa still holds considerable undiscovered biodiversity, much at a taxonomic level that may reveal evolutionary and biogeographic information. The new genus *Acaulonopsis*, of two new species, continues this extraordinary series of bryological discoveries. Given that Pottiaceae with a bulbiform habit are commonly highly reduced in expression of traits, and may be difficult to identify, a key to the genera in South Africa is here provided.

Key to genera of bulbiform habit among Pottiaceae in South Africa

1. Capsule cleistocarpic, spherical, lacking an apiculus or line of dehiscence 2
 Capsule cleistocarpic or stegocarpic, spherical and apiculate to cylindrical and operculate 3
2. Leaves short-ovate to orbicular, deeply concave throughout, smooth or weakly papillose, medial laminal cells mostly 18–30 μm in width; costa thin; perichaetial leaves little different from the cauline. *Acaulon*
 Leaves ovate, broadly channeled to concave but mostly channeled in upper half, strongly papillose, medial laminal cells mostly 10–16 μm in width; costa strong; perichaetial leaves saccate in lower half. *Acaulonopsis*

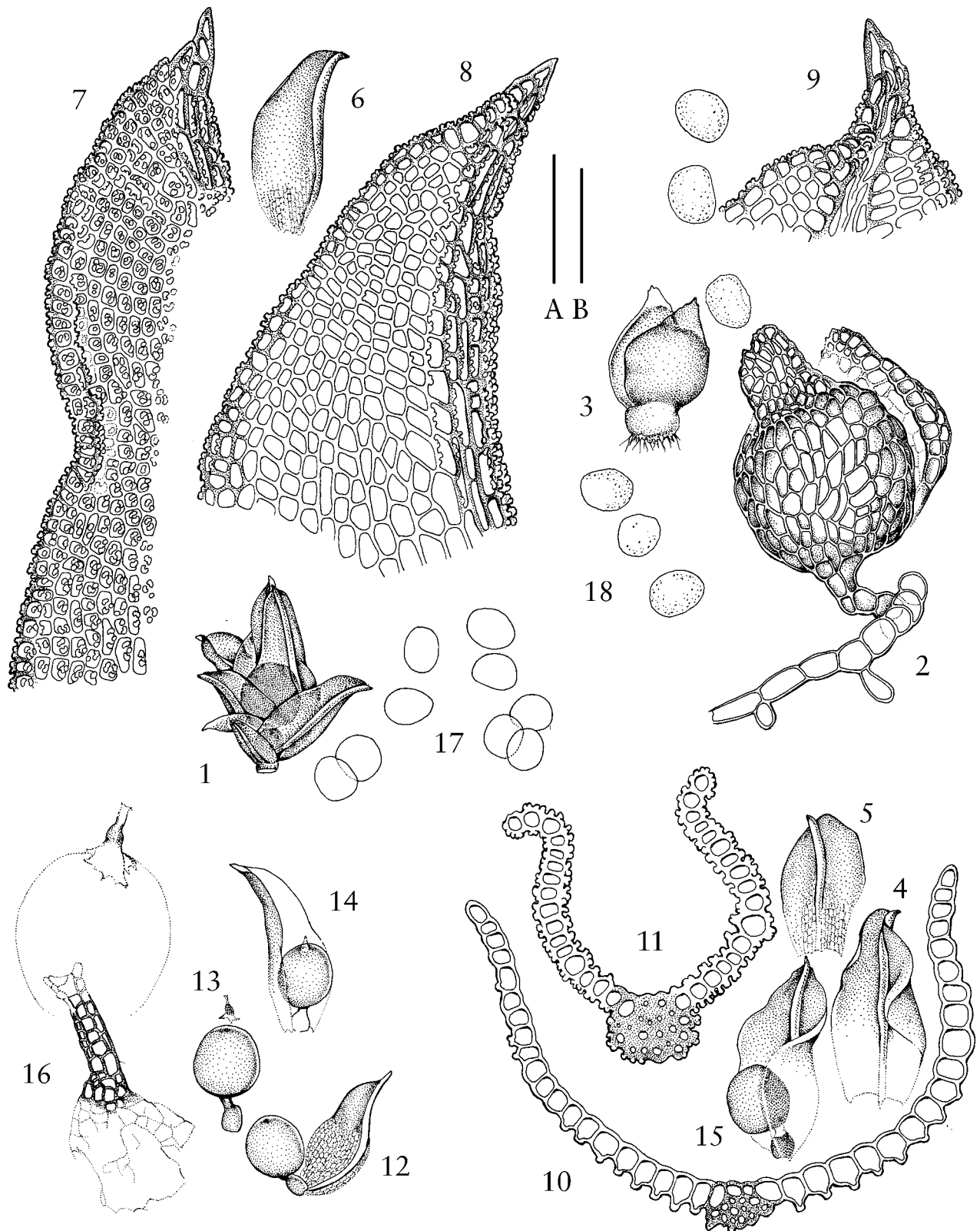


Figure 2. *Acaulonopsis eureka*. 1, habits, perichaetiate plant; 2-3, perigoniote buds; 4-6, leaves; 7-9, leaf apices; 10, transverse section near leaf base; 11, transverse section in upper half of leaf; 12-15, capsules and perichaetial leaves; 16, calyptra; 17, essentially smooth spores; 18, weakly papillose spores; Scale bars: A=1 mm, 1, 3-6, 12-15; B=50 μ m, 2, 7-11, 16-18

3. Ventral surface of costa with filamentous or lamellar excrescences 4
Ventral surface of costa concave, plane, or bulging but lacking excrescences 6
4. Both ventral surface of leaves and costa with filaments *Aloina*
Only ventral surface of costa with filaments or lamellae 5
5. Costa with filaments *Crossidium*
Costa with lamellae, occasionally additionally filaments *Pterygoneurum*
6. Capsule stegocarpic, seta very short 7
Capsule cleistocarpic or if stegocarpic then seta elongate and capsule exerted above perichaetial leaves 8
7. Leaves entire; operculum long-conic *Ludorugbya*
Leaves erose-dentate; operculum flattened-umbonate *Algaria*
8. Lamina with yellow reaction to 2% KOH ... *Tortula*
Lamina with red reaction to 2% KOH 9
9. Capsules cleistocarpic, cells in distinct circumferential pallisade-like rows; leaves densely papillose, 4–5 papillae per cell; leaves when robust rectangular-lanceolate, bordered with elongate cells, costal hydroid strand absent; when plants reduced then leaves ovate and calyptra entirely covering the capsule; vertical brown rhizoids often densely arising from turves *Vrolijkheidia*
Capsules stegocarpic, seldom cleistocarpic, cells in irregular rows or seldom in pallisades; leaves sparsely papillose, 2–4 papillae per cell; leaves ovate to ovate-lanceolate, not bordered, costal hydroid strand present; calyptra covering only apex of capsule; vertical brown rhizoids absent *Microbryum*

Vrolijkheidia peraristata (Müll. Hal.) R.H. Zander & Hedd., **comb. nov.**

Phascum peraristatum Müll. Hal., Flora 71: 3. 1888, basionym.

Vrolijkheidia circumscissa R.H. Zander & Hedd., J. Bryol. 30: 143. 2008, syn. nov.

Apparently, *Vrolijkheidia peraristata* exhibits a quasi-dimorphic or 'stature gradient' (Herzog, 1907; Zander, 1978) habitus. Extremes of the two forms are a much-reduced form with a capsule that is not or weakly apiculate, which has long-awned, short-ovate leaves, the blade 650–800 µm and the awn (170–)440–700 µm in length, with tightly recurved, weakly bordered leaf margins, and mature capsules small, 350–400 µm in length, completely covered by the calyptra, grading through a series of specimens (well-represented at MO) to the well-developed form illustrated by Hedderson and Zander (2008c), which has short-awned, elliptical to long-oblong leaves, the blade 1000–1300 µm and the awn 200–400(–550) µm in length, and capsules larger, distinctly apiculate, 450–600 µm in length, covered

by the calyptra only in the upper half. An apparently very young capsule with only acute capsule apices was illustrated by Magill (1981), which was why this taxon was examined in the course of this study. The capsule in both forms is somewhat flattened basally but more strongly in the reduced form. The genus is therefore now known to range across South Africa and southernmost Botswana. Although collections of the species at MO exhibited a range of intermediates, the species may be undergoing speciation or at least balancing selection. Characteristic of many of the collections is the generation of brown rhizoids from the axils of the upper leaves reaching vertically 1–2 mm beyond the leaves. This unique feature gives a mat a glistening, hairy appearance and may have some protective function.

ACKNOWLEDGEMENTS

We appreciate the talent and skill of Patricia Eckel in her contribution of the illustrations and Latin renderings of the descriptions. The University of Cape Town and The National Research Foundation of South Africa provided funding for the research. The Missouri Botanical Garden made available its excellent herbarium and research facilities.

TAXONOMIC ADDITIONS AND CHANGES: *Acaulonopsis* R. H. Zander & Hedd., gen. nov.; *Acaulonopsis fynbosensis* R. H. Zander & Hedd., sp. nov.; *Acaulonopsis eureka* R. H. Zander & Hedd., sp. nov.; *Vrolijkheidia peraristata* (Müll. Hal.) R. H. Zander & Hedd., comb. nov.

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