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Studies in the liverwort genus *Fossombronia* (Metzgeriales) from southern Africa. 8. *F. elsieae* and *F. spinosa*, two new Western Cape species with spinose spores

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Keywords: *Fossombronia* Raddi, *F. elsieae* Perold, *F. spinosa* Perold, Hepaticae, Metzgeriales, southern Africa, Western Cape

ABSTRACT

Two new species with spinose spores are described from the Western Cape. *F.* **elsieae** Perold is quite a large plant, generally with almost entire leaves, its spores on the distal face having relatively few, rather coarse spines, which often appear broken and are occasionally linked to form abbreviated ridges. *F.* **spinosa** Perold is a smallish plant with irregularly lobed leaves, its spores on the distal face having numerous, fine spines, which sometimes coalesce to form short ridges. A table which compares *F. glenii* Perold, *F. leucoxantha* Lehm. and *F. montaguensis* S.W.Arnell with the two new species, is supplied.

1. **Fossombronia elsieae** *Perold*, sp. nov.

Plantae dense coarctatae, apicem versus virides, cito albescentes et translucentes. *Folia* late patentia, imbricata, obovata vel suboblonga. Dioicae. *Antheridia* bracteis forma irregulari subtensa. *Pseudoperianthium* campanulatum; ore undulato cum lobis ± 6 rotundatis. *Sporae* 47.5–57.5 µm diametro, superficie distali convexa, cum 9 vel 10 seriebus spinarum grossarum conicarum, interdum in cristis irregularibus concatenatarum; superficie proximali sine nota triradiata, cum cristis brevibus et spinis nonnullis. *Elateres* 125–165 µm longi, 7.5–12.5 µm lati, omnino ter spirales vel alii bis spirales, alii apicem versus bis spirales, alii ter, raro quater apices versus ter, spirales.

TYPE.—Western Cape, 3318 (Cape Town): Table Mountain, top of Nursery Gorge, (–CD), *E. Esterhuysen 24885* (BOL, holo.).

Plants in crowded stands, apically green, soon bleached and translucent, rather fragile; shoots medium-sized to quite large, 6–12 mm long, ± 2.5 mm high, 3.5–4.5 mm wide; simple (Figure 2A) or apically furcate, segments 2–3 mm long, moderately divergent, sometimes with lateral buds toward base. *Stems* prostrate, fresh apical shoots often arising from somewhat withered base (Figure 2B), in recent collections dorsally chlorophyllose, ventrally purple, in cross section planoconvex, in male plants at apices (Figure 1N) 300–350 µm (10 cell rows) high, 500–600 µm wide and at bases (Figure 1O) 220–350 × 300–430 µm; in female plants at apices (Figure 1P) 300–400 µm (12 cell rows) high, 450–500 µm wide, tapering proximally and basally (Figure 1Q), 250–300 × 400–450 µm. *Leaves* spreading widely, overlapping, succubously inserted on stem, quite large, except for young apical ones, plane and rounded above, mostly longer than wide and narrowing toward base, obovate to almost oblong, in male plants (Figure 1A–E) 1125–2000 × 1125–1500 µm, in female plants (Figure 1F–K) somewhat larger, 1700–2125 × 1625–2125 µm, margins nearly entire, with few (1–3) papillae, mostly at slight angulations. *Leaf cells* thin-walled, in male plants tending to be slightly smaller, but not significantly so, in female plants at upper margin (Figure 1L) subquadrate to rectangular across, 45–50 × 55.0–62.5 µm, at lower lateral margins long-rectangular, 90.0–112.5 × 27.5–47.5 µm; upper laminal cells 5- or 6-sided, 62.5–80.0 × 50–55 µm; middle laminal cells 87.5–132.5 × 57.5–62.5 µm; basal cells 75–125 × 37.5–50.0 µm. *Oil bodies* present in fresh material only (Figure 1M), up to 34 per cell, shiny, globular to slightly irregular in shape, ± 5 µm diam.; chloroplasts similar in size.

Dioicous. *Antheridia* dorsal on stem, in 1 or 2 rows, short-stalked, globose, ± 270 µm diam., subtended by perigonial bracts (Figure 1R–U), single or paired (Figure 2C, D), shape irregular, body 400–500(–600) × 180–280(–310) µm, upper margin with low, blunt or tall, spinous projections, up to 300 µm long and 160 µm wide at base, tapering to a pointed tip topped with a papilla, cells in interior 5- or 6-sided, 60.0–82.5 × 37.5–45.0 µm. *Archegonia* (Figure 2E) in 1, 2 or more rows, dorsally along stem. *Pseudoperianth* (Figure 1X, Y; Figure 2F) campanulate, near stem apices, 1500–1800 µm long, sometimes slit along the side, one margin overlapping the other, base narrow, ± 875 µm wide, upwardly widely flaring, 2250–2625 µm across undulating mouth, with ± 6 rounded lobes, marginal papillae few, cells comparable in shape and size to those of leaves. *Capsules* globose, ± 625 µm diam., cells in inner layer of bistratose capsule wall (Figure 1V) ± rectangular, roughly triangular or irregularly shaped, 52.5–65.0 × 30–50 µm, each cell wall with 1–3 nodular and some semi-annular thickenings. *Seta* from very short to 3.25 mm long, 150 µm or 9 cell rows wide (Figure 1W). *Spores* brown to dark brown, hemispherical, 47.5–57.5 µm diam. including spines projecting around periphery; distal face convex (Figure 3A–D), covered with 9 or 10 rows of coarse, often conical spines (or a total of ± 39), ± 5 µm long, basally joined by fine lines, sides grooved, apices sometimes 'broken', apparently hollow inside, occasionally linked to form irregular ridges; proximal face (Figure 3E) almost flat, lacking a distinct triradiate mark, with short, slightly sinuous or occasionally branched ridges and some blunt

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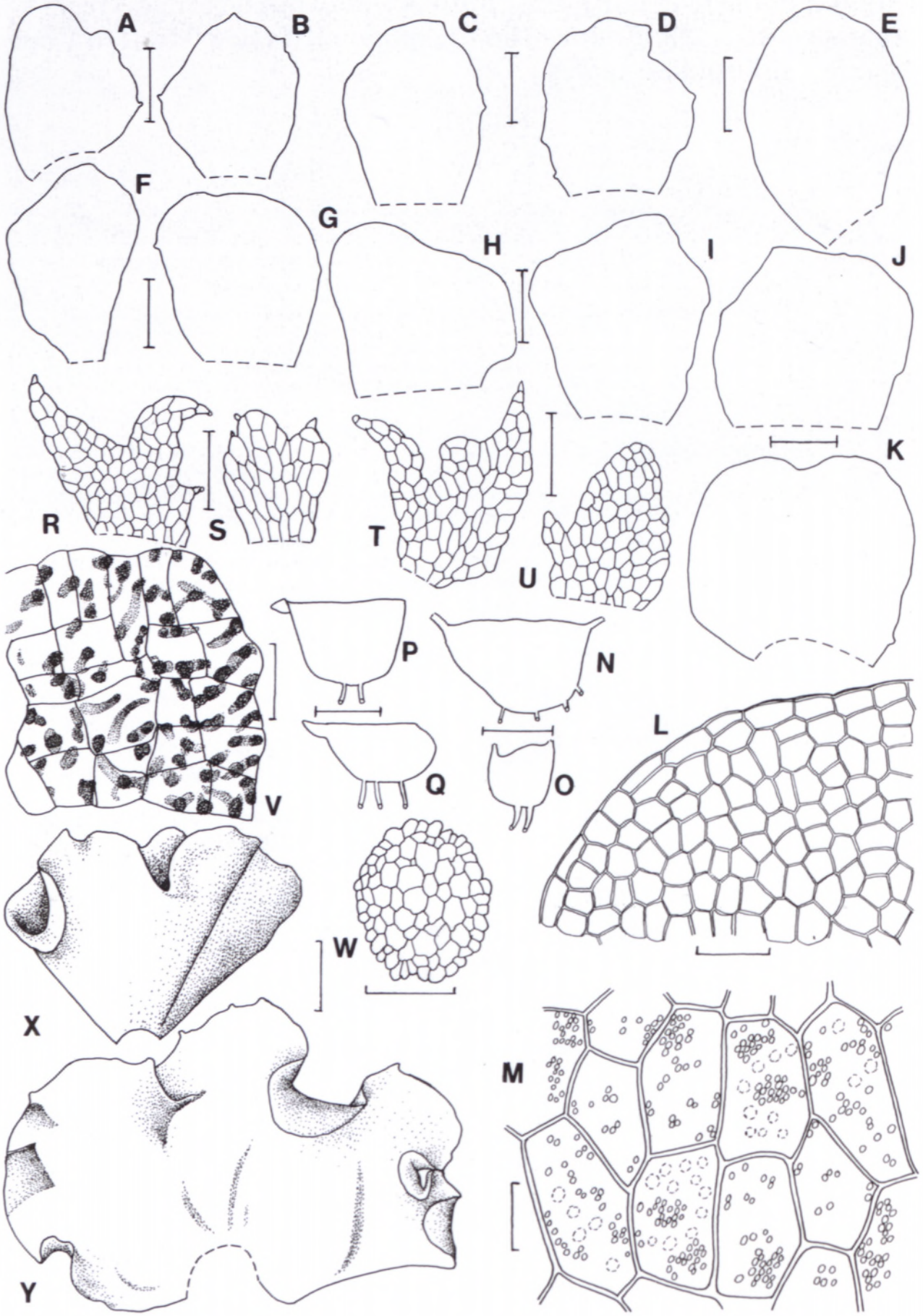

FIGURE 1.—*Fossombronia elsieae*. A–E, leaves of male plant; F–K, leaves of female plant; L, detail of marginal area of leaf; M, median leaf cells with oil bodies (solid lines) and chloroplasts (dotted lines); N, c/s apical part of male stem; O, c/s basal part of male stem; P, c/s apical part of female stem; Q, c/s basal part of female stem; R–U, perigonial bracts; V, cells in capsule wall with thickenings; W, c/s seta; X, pseudoperianth from side; Y, opened pseudoperianth. A–L, N–V, X, Y, *Esterhuysen 24885*; M, W, *Braggins 97/356A*. Scale bars: A–K, X, Y, 500 µm; L, W, 100 µm; M, V, 50 µm; N–Q, R–U, 250 µm.

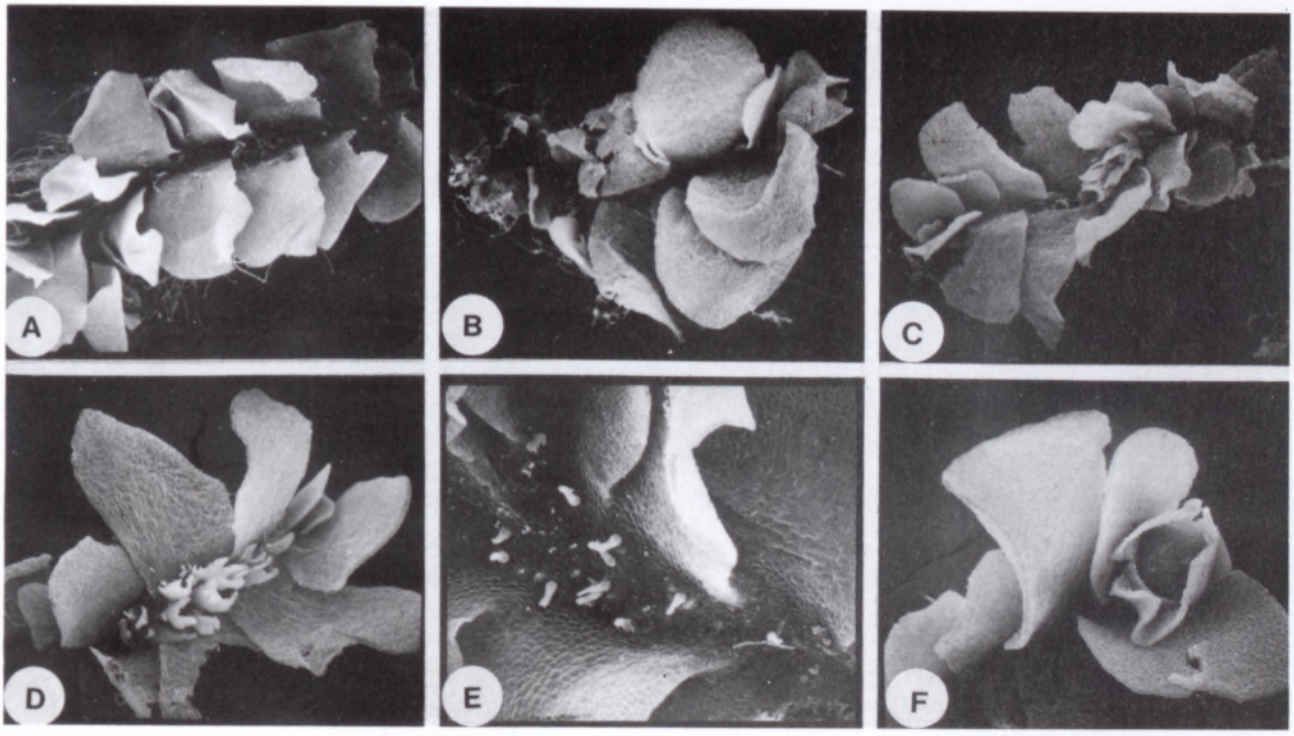

FIGURE 2.—*Fossombronia elsieae*. A, simple shoot; B, fresh apical shoot from rather withered base; C, D, male stem with perigonial bracts; E, female stem with archegonia from above; F, female stem with pseudoperianth and capsule from above. A, E, *S.M. Perold 3475*; B–D, F, *Esterhuysen 24885*. A, × 7.8; B, × 12.8; C, × 10.5; D, × 16; E, × 17; F, × 17.

spines in between, 21–25 spines projecting around periphery. *Elaters* (Figure 3F) yellow, smooth, 125–165 µm long, 7.5–12.5 µm wide in centre, often tapered toward tips and ending in a loop, 5 µm wide; 3-spiral along entire length, occasionally 2-spiral only at tips, remainder 3-spiral; some wholly 2-spiral; rarely loosely 4-spiral, tapering tips 3-spiral, or only exceptionally branched into 2 near apex, both tips 2-spiral, the lower, unbranched part 3-spiral.

Fossombronia elsieae has been named in honour of Ms Elsie Esterhuysen, the doyenne of southern African plant collectors, who collected it in October 1951 at the top of Nursery Gorge, Table Mountain. This specimen was

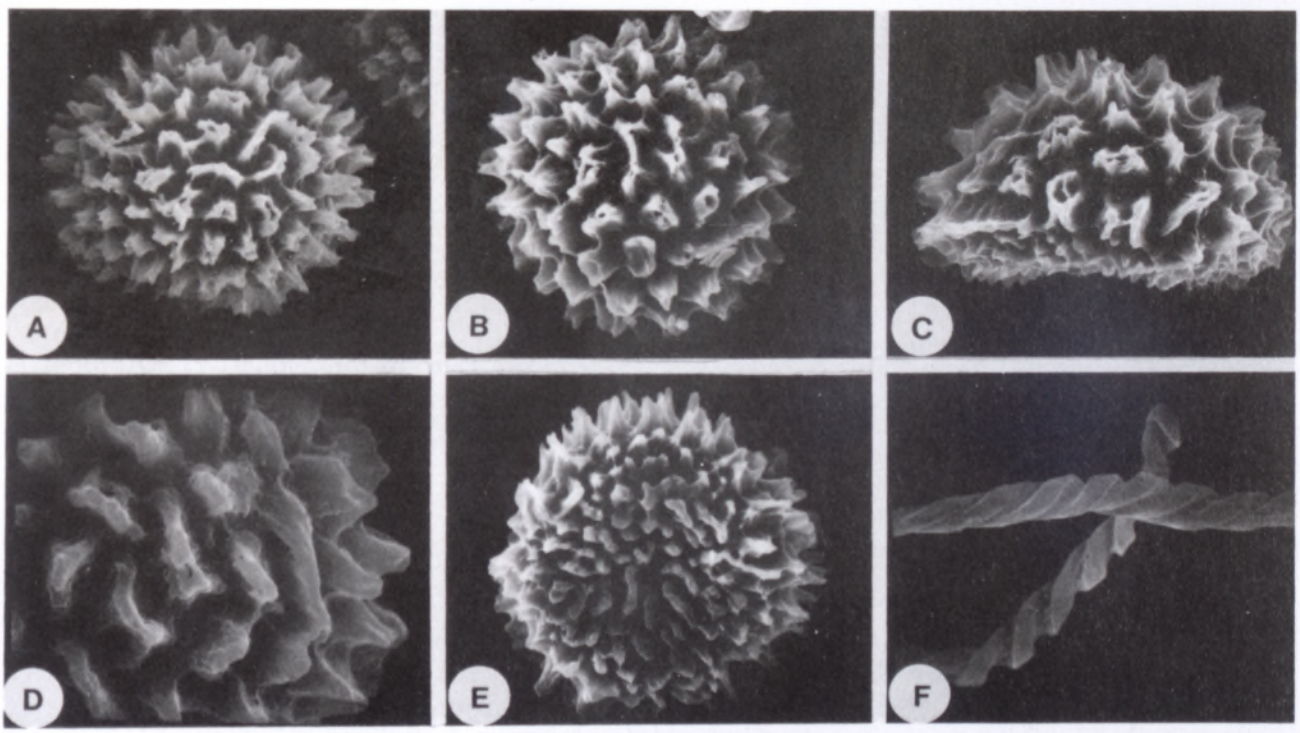

FIGURE 3.—*Fossombronia elsieae*. Spores and elaters. A, B, distal face; C, side view of distal face; D, detail of spines and lamellae at margin of distal face; E, proximal face; F, elaters. A, *S.M. Perold 3475*; B–F, *Esterhuysen 24885*. A, × 761; B, × 711; C, × 876; D, × 1560; E, × 715; F, × 1013.

TABLE 1.—Comparison of some characters of *F. elsieae*, *F. spinosa*, *F. glenii*, *F. leucoxantha* and *F. montaguensis*

Character	*F. elsieae*	*F. spinosa*	*F. glenii*	*F. leucoxantha*	*F. montaguensis*
Length of shoot (mm)	6–12	up to 9	5–7	up to 7	up to 10
Height of leafy shoot (mm)	2.5	1.1–1.6	1.8	2.6	1.1–2.0
Width of leafy shoot (mm)	3.5–4.5	1.4–2.4	3.0	up to 4.0	1.8–3.5
Shape of scales	obovate to oblong	irregular, above with 3 or 4(5) angular lobes	oblong, subtruncate above with shallow angular lobes	± half-opened fan, irregularly rounded to nearly truncate above	subquadrate to long-rectangular or irregular
margin	almost entire, papillae few	'ruched', with (4–)5–16 papillae	with 1 or 2 papillae	'ruched', incised-dentate, with 7–24(–30) projections, topped with a papilla	frilly, with triangular or irregular projections, 6–16 papillae
size of female plants (µm)	1700–2125 × 1625–2125	800–1375 × 825–1650	2000–2500 × 1325–2500	1575–2250 × 1875–3950	1375–2500 × 1175–1950
Sexuality	dioicous	dioicous	dioicous	dioicous	?dioicous: no antheridia seen
Antheridia diam. (µm)	270	230	210	320–380	–
bracts	with spinous projections	with pointed projections	with finger-like projections	margins with papillae	–
Pseudoperianth	sometimes slit		deeply cleft 4–6 times		
length (µm)	1500–1800	1250–1500	± 1750	1500–2250	up to 2575
width at mouth (µm)	2250–2625, with ± 6 rounded lobes and few papillae	± 2500, convoluted, with ± 15 projections, some spinous, others angular	2250–2375, often reddish, with 4–6 deep lobes	2375–4375, with up to 39 toothed processes, topped by a papilla	2375–3000, with ± 30 triangular protrusions, topped with a papilla
Spores					
diam. (µm)	47.5–57.5	35–45	40.0–52.5	42.5–55.0	40.0–47.5
distal face	9 or 10 rows of coarse, often conical spines (total ± 39), ± 5 µm long, sometimes broken	11–15 rows of fine spines (total ± 95), 5 µm long, some with truncate tips, occasionally broken	up to 70, 5 µm long, conical spines, some double, others joined into short ridges, rarely broken	12–15 irregular rows of truncate or conical spines (total ± 90), 5 µm long, with small papillae in between and buttressing ridges	up to 10 irregularly branched, long or short, sinuous ridges, some breaking up into spines, others interconnected, forming areolae
around circumference	21–25 spines	± 40 spines	± 30 spines	27–35 spines	± 27 blunt, spine-like papillae
Elaters					
size (µm)	125–165 × 7.5–12.5	100–150 × ± 7.5	70.0–137.5 × 7.5–10.0	130–200 × 7.5	137.5–175.0 × 7.5
spirals	3-spiral or 2-spiral or variable	2-spiral or 3-spiral throughout or 3-spiral in middle and tips 2-spiral	2- and sometimes 3-spiral in same one	2-spiral or 3-spiral	2-spiral throughout or partly 3-spiral

misidentified by Arnell as *F. crispa*. In my paper re-examining *F. leucoxantha* Lehm. (Perold 1997c), I referred to this collection, which I have now selected as the holotype of this new species, stating that it has 'almost entire leaves'. I thus distinguished it from *F. leucoxantha*, which has 'denticulate to incised-dentate leaves', in spite of both species having spinose spores. The spores in *F. leucoxantha* almost invariably have papillae between the at least 90 spines covering the distal face, whereas in *F. elsieae* there are no papillae and only up to 39, rather coarse, often broken spines on the distal face. Clearly, there are subtle differences between these two species (and *F. spinosa*) in the spore ornamentation, but much more obvious differences vegetatively. In the recently described *F. glenii* (Perold 1997a) from the northern summer rainfall region, the spines on the distal face of the spores are often double and the ± undulating leaf margins have shallow angular lobes. In Table 1, some characters of *F. elsieae* and *F. spinosa* are compared to those of *F. glenii* Perold, *F. leucoxantha* and *F. montaguensis* S.W.Arnell.

In addition to the methodology employed by Scott & Pike (1988), and others, who relied 'almost completely on spore characters—surface sculpturing, often colour and, much less, spore size—for discriminating species', I have tried to use vegetative characters also. Extensive use of LM and SEM micrographs of the spores and thalli has, of course, made comparison between specimens easier. At times, however, it remains extremely difficult to establish species parameters in this genus. Accordingly, I am still undecided where to place the other specimen, *Arnell 616*, which I also excluded from *F. leucoxantha* in my treatment of that species (Perold 1997b). Other species with coarse spines on the distal spore face have been described from elsewhere in the world, notably *F. caespitiformis* De Not., which has a total of only ± 25 spines on the distal face and ± 29 around the periphery. Vegetatively it does not appear to be closely related to *F. elsieae*, nor do the Australian species with coarsely spinose spores, *F. cultriformis*, *F. magnaspora* and *F. truncata*, which were described by Scott & Pike (1987).

Fossombronia elsieae (and *F. spinosa*), with spores ripening in spring (September/October), are hitherto known from only a few localities in the Western Cape (Figure 4), which is in the winter rainfall area of southern Africa. This is referred to as the Fynbos Biome (sclerophyllous, microphyllous vascular plant vegetation) (Cowling *et al.* 1997; Rutherford 1997), or else the area is called the Cape Region—phytogeographic region based on the distribution of vascular plants (Cowling & Hilton-Taylor 1997). The holotype specimen of *F. elsieae*, as already mentioned, was collected on Table Mountain. It grew on black, humus-rich soil containing quartz grains derived from Table Mountain sandstone. Other specimens referred here are *Braggins 97/354* from Silvermine Reserve, near Kalk Bay as well as *Braggins 97/356A* from Stinkwood Trail, Kirstenbosch. Their spore ornamentation is closely similar to that of the holotype specimen, but some of the leaves are apically divided into 2 ± triangular lobes. *Schelpe 6368* is from Bain's Kloof, Witte River and *Perold & Koekemoer 3475* is from Tradouw Pass. *F. elsieae* is distinguished by its fairly large size, by its obovate to oblong, almost entire leaves, as well as by its spores with the distal face having relatively few, rather coarse spines which are occasionally linked to form short ridges.

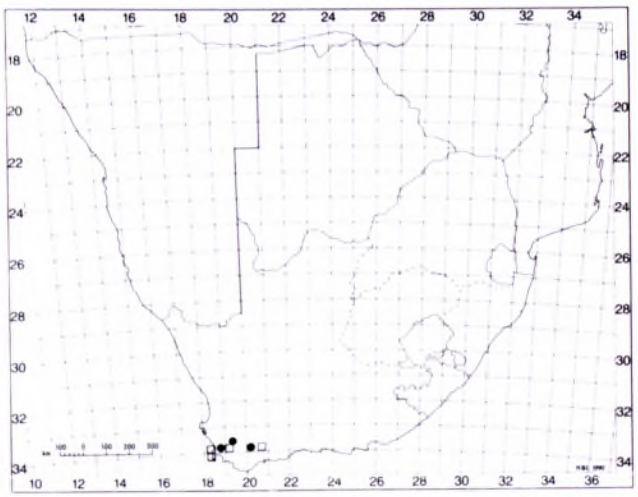

FIGURE 4.—Distribution of *F. elsieae*, ❑; and *F. spinosa*, ●, in southern Africa.

2. **Fossombronia spinosa** *Perold*, sp. nov.

Plantae dense coarctatae, laete virides, apicibus vel solum marginibus foliorum apicalium purpureis. *Folia* suberecta, imbricata, plicata, supra irregulariter lobata. Dioicae. *Antheridia* bracteis obtecta, marginibus superioribus cum processibus acutis. *Pseudoperianthium* infundibuliforme; ore convoluto, cum processibus angulatis vel spinosis. *Sporae* 35–45 µm diametro, superficie distali convexa, cum 11–15 seriebus spinarum tenuium, interdum in cristis brevibus concatenatarum; superficie proximali sine nota triradiata, subtiliter vel grosse granulari, cum lamellis tenuibus nonnullis. *Elateres* 100–150 µm longi, medio ± 7.5 µm lati, laxe bis vel ter spirales, vel medio ter et apices versus bis spirales.

TYPE.—Western Cape, 3320 (Montagu): Kogman's Kloof, 5 km from Montagu, immediately beyond tunnel on road to Ashton, at Loftus Bridge, along disused road along the left side of the river; on soil on vertical rock face, (–CC), *S.M. Perold 3835* (PRE, holo.).

Plants in dense colonies, bright green, apical tips occasionally entirely purple or else only margins of young leaves deeply stained dark red; shoots smallish, up to 9 mm long, (0.9–)1.1–1.6 mm high, 1.4–2.4 mm wide; rarely simple (Figure 5A), mostly apically furcate, terminal segments 2–4 mm long, moderately to widely divergent, side branches 1–3, apparently arising from lateral buds. *Stems* prostrate, sometimes arched, apices tuberous, occasionally slightly raised, plano-convex in cross section, in male plants (Figure 6F) ± 220 µm (10 cell rows) high, ± 420 µm wide, basally (Figure 6G), ± 210 × 400 µm; in female plants apices (Figure 7O) ± 280 µm (11 cell rows) high, ± 450 µm wide, tapering proximally and basally (Figure 7P), ± 150 × 250 µm; dorsally chlorophyllose, ventrally purple. *Rhizoids* purple, 10–15 µm wide, often with internal mycorrhizal strands. *Leaves* suberect, overlapping, decurrent, succubously inserted, apically small, soon becoming larger, shape irregular, often shorter than wide, in male plants (Figure 6A–E) 625–825 × 825–1200 µm, in female plants (Figure 7A–L) 800–1375 × 825–1650 µm, mostly some-

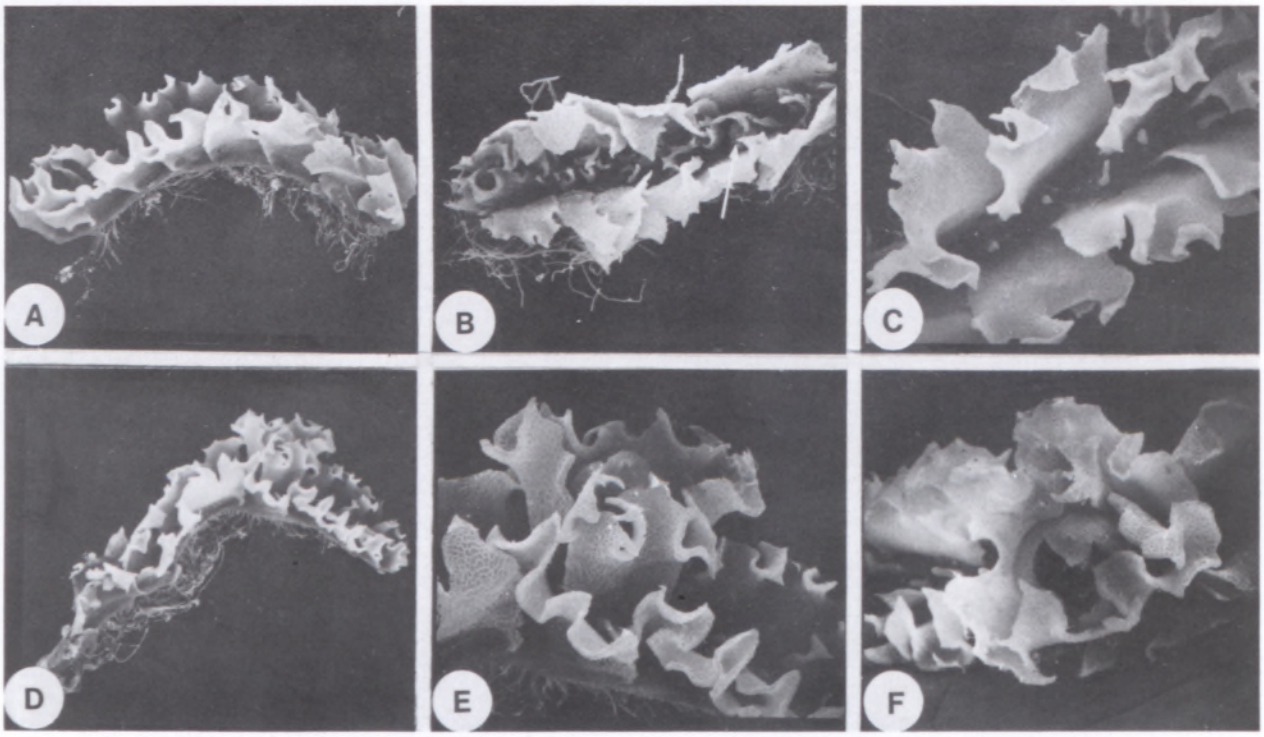

FIGURE 5.—*Fossombronia spinosa*. A, simple shoot seen partly from side; B, male stem with row of perigonial bracts from above, antheridium indicated by arrow; C, female stem with row of archegonia from above; D, shoot with pseudoperianth; E, close-up view of pseudoperianth; F, pseudoperianth with capsule (wall disintegrating) from above. A, C–F, *S.M. Perold 3834*; B, *S.W. Arnell 738*. A, × 9.6; B, × 19.7; C, × 18; D, × 8.2; E, × 22; F, × 21.

what narrower below, 'ruched' and irregularly lobed above, with 3 or 4(5) rather angular lobes, 400–500 × 450–500 µm, margins with (4)5–16 papillae, mostly sessile, sometimes raised on 1 or 2 basal cells. *Leaf cells* thin-walled, in male plants not appreciably different from those of female plants, at upper margin (Figure 7M) subquadrate to rectangular across, 20.0–37.5 × 27.5–42.5 µm, at lateral margins long-rectangular, 40.0–87.5 × 22.5–32.5 µm; upper laminal cells 5- or 6-sided, 37.5–47.5 × 30–45 µm; middle laminal cells 42.5–62.5 × 30.0–37.5 µm; basal cells 55–75 × 42.5–52.5 µm. *Oil bodies* (Figure 7N) 6–27 per cell, shiny, globose, ± 2.5 µm diam.; chloroplasts numerous, rounded, ± 5 µm diam.

Dioicous. Male plants rare. *Antheridia* dorsal on stem, in 1 or 2 rows (Figure 5B), short-stalked, globose, ± 230 µm diam., each one shielded by a bract (Figure 6H–K), 230–340 × ± 330 µm, sometimes 2 adjacent ones joined together, upper margins with pointed projections up to 180 µm long, marginal cells above 27.5–37.5 × 25.0–32.5 µm, cells in interior 4- or 5-sided, 25–45 × 30–35 µm. *Archegonia* in a row dorsally along stem (Figure 5C). *Pseudoperianth* (Figures 5D, E; 7Q, R) proximal to stem apex, sometimes 2(or 3) close together, funnel-shaped, raised on a short stalk, ± 500 × 675 µm, widely flaring above, 1250–1500 µm high, up to 2500 µm wide across convoluted mouth, divided into ± 15 irregularly-shaped projections, some spinous, ± 120 µm long, others angular, up to 450 µm wide, cells comparable in shape and size to those of leaves. *Capsules* globose (Figure 5F), 625–875 µm diam., cells in inner layer of bistratose capsule wall roughly quadrangular, rectangu-

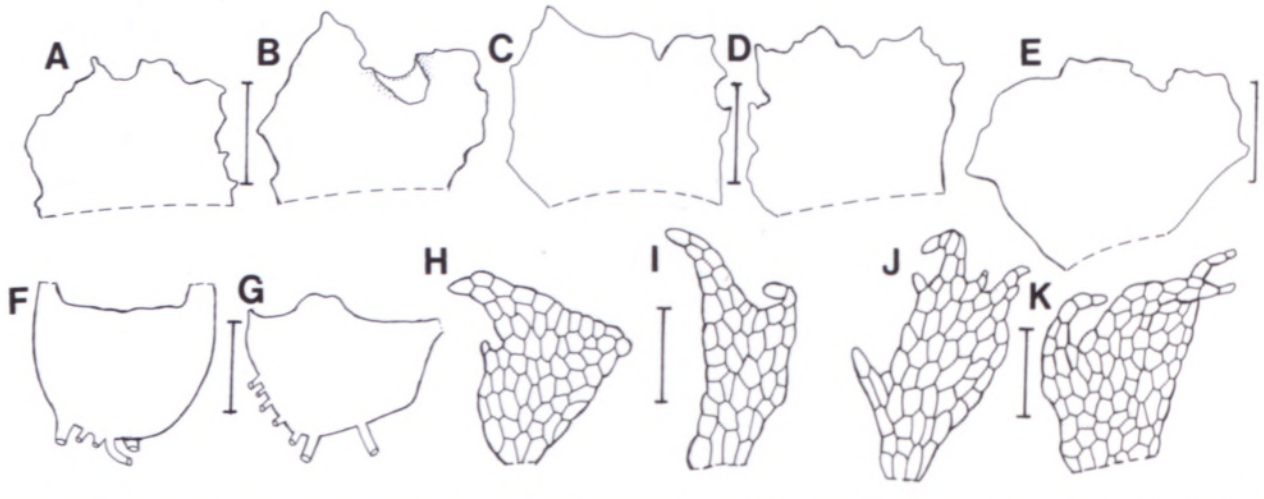

FIGURE 6.—*Fossombronia spinosa*. A–E, leaves of male plants; F, c/s apex of stem of male plant; G, c/s base of stem of male plant; H–K, perigonial bracts. A–K, *S.W. Arnell 735*. Scale bars: A–E, 500 µm; F–K, 250 µm.

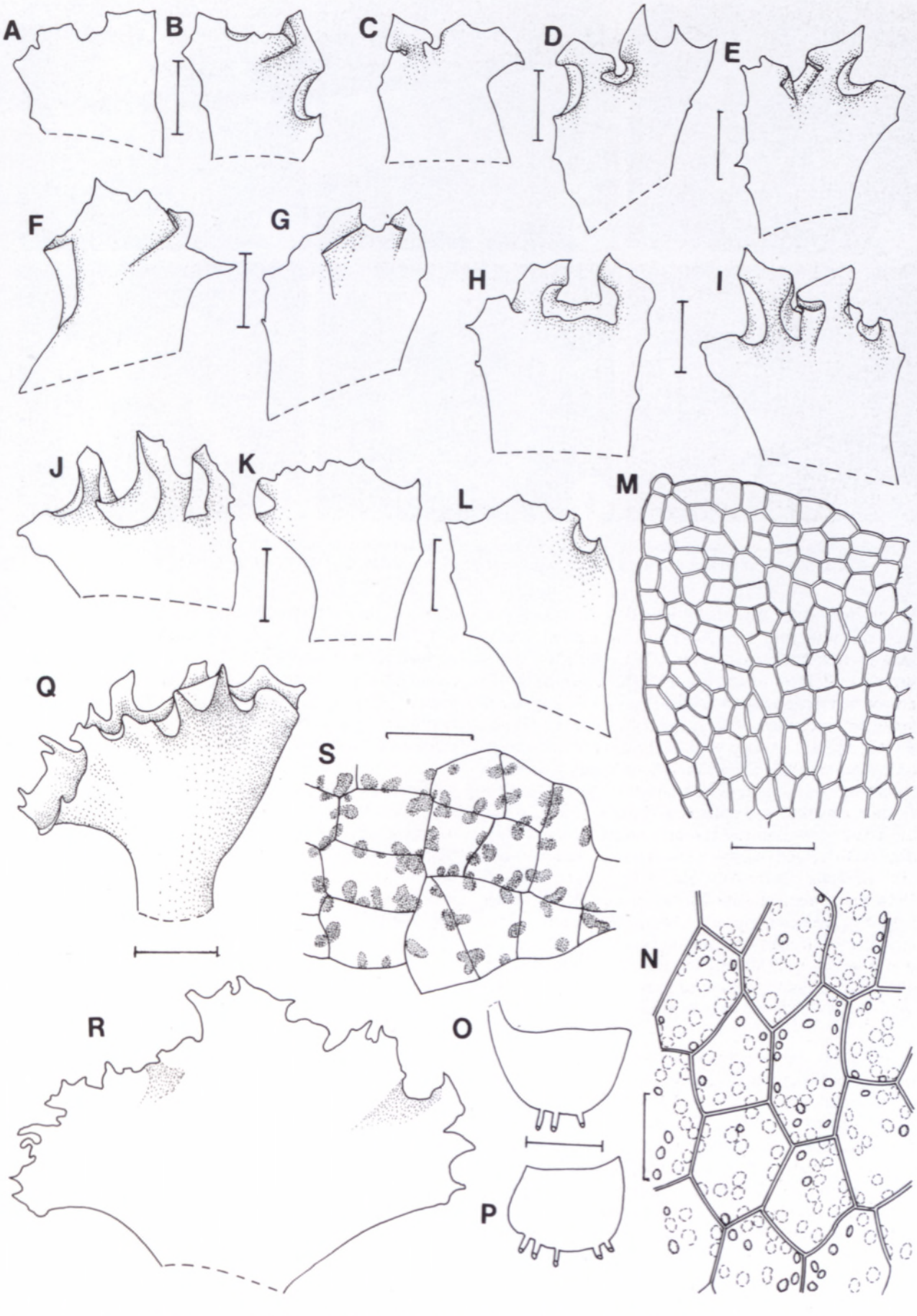

FIGURE 7.—*Fossombronia spinosa*. A–L, leaves of female plant; M, detail of marginal area of leaf, with papilla; N, median leaf cells with oil bodies (solid lines) and chloroplasts (dotted lines); O, c/s apex of stem of female plant; P, c/s toward base of stem of female plant; Q, pseudoperianth from side; R, opened pseudoperianth; S, cells in capsule wall with thickenings. A, B, N, Q, R, *S.M. Perold 3834*; C–J, O, S, *S.M. Perold 3835*; K, L, P, *Schelpe s.n.* Scale bars: A–L, Q, R, 500 µm; M, 100 µm; N, S, 50 µm; O, P, 250 µm.

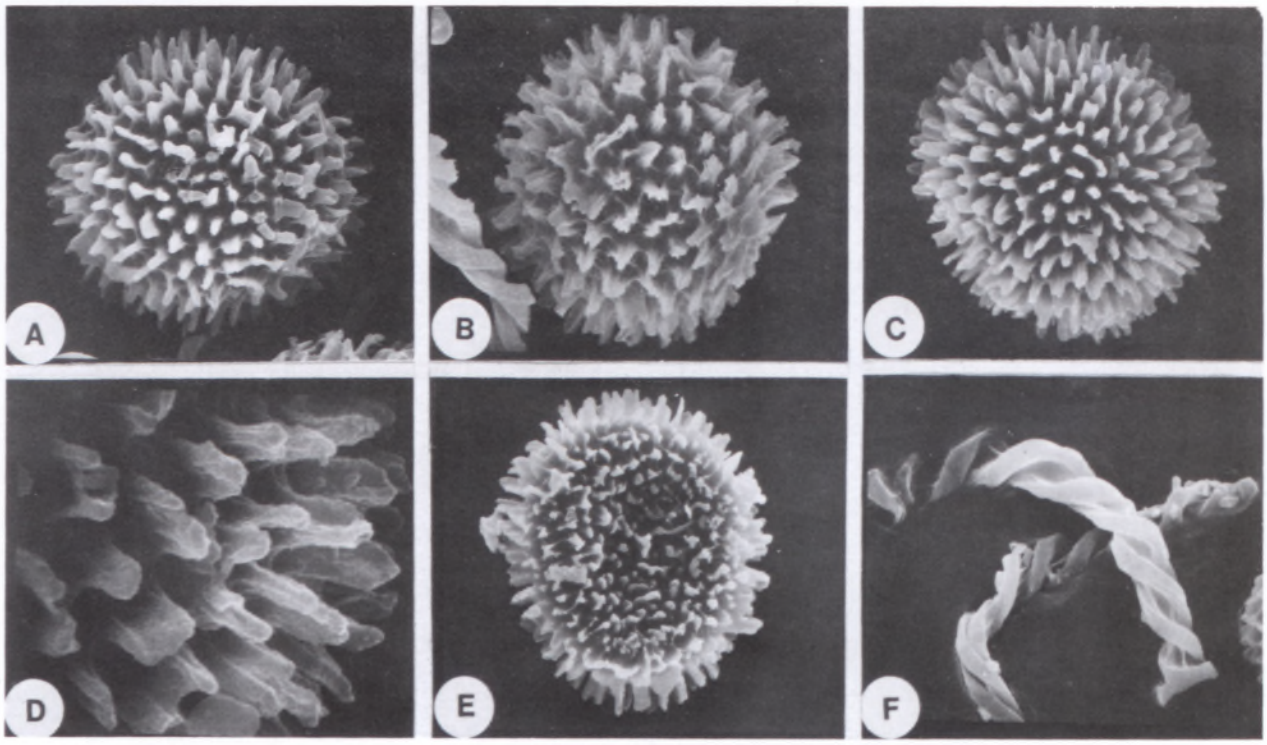

FIGURE 8.—*Fossombronia spinosa*. Spores and elaters. A–C, distal face; D, detail of spines at margin of distal face; E, proximal face; F, elaters. A, F, *S.M. Perold 3835*; B, *S.W. Arnell 735*; C–E, *Schelpe s.n.* A, × 959; B, × 986; C, × 734; D, × 2294; E, × 674; F, × 863.

lar or irregularly shaped, 32.5–75.0 × 20.0–37.5 µm, each cell wall with 1 or 2(–4) nodular and only rarely semi-annular thickenings (Figure 7S). *Seta* 1.0–2.9 mm long, 200–350 µm diam. *Spores* light brown to darker brown, hemispherical, 35–45 µm diam., including spines projecting around periphery; distal face convex (Figure 8A–C), densely covered with 11–15 rows of fine spines, (or a total of ± 95), almost smooth or faintly grooved, ± 5 µm long, apices quite often truncate (Figure 8D), occasionally 'broken' and apparently hollow inside, sometimes linked to form several short ridges; proximal face (Figure 8E) slightly concave or almost flat, lacking a distinct triradiate mark, finely to coarsely granular and with some thin, irregular lamellae, numerous (± 40) spines projecting around periphery. *Elaters* (Figure 8F) yellow, mostly smooth, 100–150 µm long, ± 7.5 µm wide in the centre and tapering slightly toward tips, ending in loops, loosely 3- or 2-spiral throughout, or 3-spiral in the middle and 2-spiral at one or both tips.

The name *Fossombronia spinosa* refers to its finely spinose spores and the species is so far known from only three localities in the Western Cape (Figure 4), which is in the winter rainfall area of southern Africa. The holotype specimen of *F. spinosa* and *Perold 3834* grow on pockets of sandy, rather coarse soil derived from sandstone, on a vertical rock face, kept damp by seepage water. They are mixed with *Targionia hypophylla*, *Riccia* species, *Goniomitrium africanum* and *Bryum* species.

Some of Arnell's collections of this newly isolated species, *S.W. Arnell CH4037*, *793*, from Bath Kloof and Kogman's Kloof, Montagu, as well as my own sterile specimens, *S.M. Perold 3453* and *3454* p.p., from Bath Kloof have regrettably been wrongly identified as *F. montaguensis* (see Table 11). In Perold (1997b: figs 8C, D; 9A, B), the figures purporting to illustrate *F. montaguensis*, are actually those of *F. spinosa*. *Arnell 735* had been identified as *F. leucoxantha*, no doubt on account of its spinose spores. The Schelpe specimen was collected at Malmesbury Common on clayey soil more than 40 years ago. I returned there in 1997, but failed to find more material of this species. *Koekemoer 1415* p.p. is from the outskirts of Worcester.

Fossombronia spinosa can be recognised by its rather small size, frilly, angularly lobed leaves and finely spinose spores, of which some spines coalesce to form short ridges. *F. leucoxantha*, also from the Western Cape, has similar finely spinose spores, but mostly with papillae interspersed between the spines, and has 'incised-dentate' leaves (Table 1).

SPECIMENS EXAMINED

Held at PRE, unless otherwise indicated. Bracketed numbers after collectors' name and number refer to the species in the text in alphabetical order, namely: *F. elsiei* (1) and *F. spinosa* (2).

Arnell 735 (2) BOL; *785* p.p. (2); *793* (= *CH4033*) (2); *793* (= *CH4035*) (2); *CH4037* (2).
Braggins 97/354, *97/356A* (1).
Esterhuysen 24885 (1) BOL (holotype); *s.n.* (1) BOL.
Koekemoer 1415 p.p. (2).
S.M. Perold 3834 (2); *3835* (2) (holotype). *Perold & Koekemoer 3475* (1).
Schelpe 6368 (1) BOL; *s.n.* (2) BOL.

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