

# Studies in the Ricciaceae of sub-Saharan Africa: a provisional key to the currently known species

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## ABSTRACT

A provisional key to the currently known Ricciaceae species of sub-Saharan Africa is given and is illustrated with micrographs of the distal and proximal spore faces of each species, wherever possible.

## INTRODUCTION

For the following reasons I have deemed it advisable to publish a provisional key to the sub-Saharan Ricciaceae, prior to an intended revision of the family of the entire region projected for the not too distant future: 1, it has been brought to my notice several times that such a key would be useful to collectors of the family in tropical Africa; 2, a key to the spores of the southern African species is available (Perold 1989e) but no comprehensive key to the southern African species has been published to date. Such a key was included in my unpublished Ph.D. thesis (Perold 1991d) and it will form part of my treatment of the Marchantiidae for the Cryptogam series of the *Flora of southern Africa* projected for 1997.

In my paper, 'A survey of the Ricciaceae of tropical Africa' (Perold 1995), I deliberately omitted such a key and listed the species alphabetically, as I only intended to

report on what was currently known of the family in sub-Saharan Africa, as a preliminary to revising the family in this very undercollected region. In 1994, in an effort to encourage the collection of more *Riccia* specimens, I had submitted requests to all the African delegates present at the AETFAT congress in Wageningen, The Netherlands, asking them to please collect Ricciaceae specimens in their countries and to send duplicates to me, but I have had no response from them, only from a few European collectors who have visited Africa in recent years and to whom I wish to express my sincere gratitude.

Although this key is therefore largely provisional, I hope that it will serve as an identification aid to collectors of African Ricciaceae. Spore micrographs have been included to facilitate the task; unless otherwise stated, all specimens cited in the captions of the figures, are held at PRE.

## ARTIFICIAL KEY TO THE GENERA, SUBGENERA, SECTIONS, GROUPS AND SPECIES OF THE RICCIACEAE IN SUB-SAHARAN AFRICA

### Key to the two genera of the Ricciaceae

- 1a Thalli floating or terricolous; assimilation tissue containing large air chambers in several storeys; scales long, pendent, purple ribbons, but small in land form, margins dentate; oil cells present; gametangia located only along deep central groove . . . . . *Ricciocarpos*  
(only one species is included here, namely *R. natans* (L.) Corda) (Figure 1A, B)
- 1b Thalli with very rare exceptions terricolous; assimilation tissue spongy, containing air chambers (subgenus *Ricciella*), or else compact, consisting of cell columns enclosing narrow vertical air canals (subgenus *Riccia*); scales small to large, imbricate, mostly rounded, margins smooth, rarely denticulate; oil cells absent; gametangia located along groove or scattered . . . . . *Riccia* (all other species are included here)

### Key to the taxa of the genus *Riccia*

- 1a Thalli covered by a dorsal epidermis of mostly thin-walled, generally chlorophyllose cells, very rarely dorsally bearing cellular outgrowths; air pores fewer in number than in subgenus *Riccia*, mostly delimited, often ringed by smaller cells, well spaced, frequently becoming cavernous; assimilation tissue loosely arranged, spongy, unistratose cell plates enclosing large polyhedral air chambers; ventral scales small and evanescent to occasionally large and persistent, in 1 or 2 ranks when present; habitat mostly mesic, rarely xeric or aquatic; spores separating at maturity or remaining in tetrads: (1b on p. 97)
- 2a Dorsal epidermis a single layer of thin-walled, closely joined, flattened cells (very rarely globose, and then somewhat loosely connected), interrupted by air pores, becoming cavernous over air chambers or not; scales ventral, mostly hyaline and inconspicuous, evanescent: (2b on p. 97)

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- 3a Thalli annual or perennial; sometimes in rosettes; always terrestrial; branches not strap-shaped, 2–15 × (1–)3–6(–8) mm; often becoming slightly to markedly cavernous; monoicous or dioicous; sporangia deeply imbedded or bulging somewhat dorsally or ventrally;
- 4a Spores separating at maturity:
- 5a Thalli moderately thick and ± opaque, not translucent; branches 2–8 times wider than thick; storage tissue up to ± ½ the thickness of thallus; spores (50)65–150(–160) µm in diam., polar, tetrahedral, winged, ornamentation reticulate, rarely with vermiculate ridges (subgenus *Ricciella*):
- 6a Thalli not inflated but finely to coarsely spongy; dorsally not deeply grooved or rarely only apically so; often in complete or partial rosettes; glaucous green to yellow green, sometimes tinged with red or purple (section *Spongodes*, group 'Crystallina'):
- 7a Thalli monoicous; from above air chamber walls visible or not; spores completely or incompletely reticulate:
- 8a Thalli blue-green; in complete or partial rosettes; from above air chamber walls not clearly visible; without or with tiny hyaline ventral scales; spores 52–85 µm in diam., light brown, ornamentation on proximal and distal faces similar:
- 9a Thalli dorsally crystalline and glistening, with rounded cells in loose double tiers, usually obscuring air pores when fresh, with age becoming spongy; scales absent or evanescent; ornamentation on 2 spore faces similar, areolae regular and complete, on distal face 8–10 across, 7.5–10.0 µm wide, walls thin and much higher at nodes, often with bifid or trifid processes, triradial mark on proximal face distinct, each facet with up to 20 areolae, 5.0–7.5 µm wide ..... *R. crystallina* (Figure 1C, D)
- 9b Thalli dorsally vesicular-areolate, air pores not obscured, soon spongy; ventral scales tiny; ornamentation on 2 spore faces similar, areolae regular and mostly complete on both faces, distal face with only 5 or 6 areolae across, 12.5–17.5 µm wide, proximal face with up to 13 areolae on each facet, walls with crenulate edges, mostly not higher at the nodes and lacking bifid processes ..... *R. vulcanicola* (Figure 1E, F)
- 8b Thalli yellow-green or blue-green, sometimes developing red or purple-red coloration; in rosettes or in gregarious patches; from above air chamber walls visible, air chambers large or small; small, purple, ventral scales sometimes present; spores 65–115 µm in diam., red-brown to black or light brown, ornamentation on distal and proximal faces dissimilar:
- 10a Thalli green to yellow-green, faintly tinged with red at margins; in rosettes; from above walls of large air chambers visible or air chambers cavernous; scales absent; spores 85–115 µm in diam., red-brown to black, distal face with thicker, irregularly bi- or trichotomously branching ridges, proximal face with triradial mark distinct, areolae incomplete ..... *R. cavemosa* (Figure 2A, B)
- 10b Thalli blue-green; in gregarious patches; from above finely areolate; scales present, purple or hyaline; spores 65–85 µm in diam., light brown, distal face with 8–10 areolae across, proximal face with triradial mark absent but with numerous tiny, shallow areolae ..... *R. moenkemeyeri* (Figure 2C, D)
- 7b Thalli dioicous; heterothallic with smaller male plants; bright green to yellowish green or grey-green; in rosettes; from above air chamber walls visible, becoming cavernous or hardly so; spore ornamentation foveolate or vermiculate (section *Spongodes*, group 'Cupuliferae'):
- 11a Thalli bright green; in medium-sized rosettes; cavernous with age; dorsal pores fairly conspicuous, soon enlarging with age; spores 95–122 µm in diam., ornamentation foveolate, with small, deep-set areolae, triradial mark on proximal face very prominent; distribution restricted to southern Africa ..... *R. cupulifera* (Figure 2E, F)
- 11b Thalli grey-green, slightly purple at margins; in small rosettes; dorsal pores slightly enlarging with age; spores 40–65 µm in diam., ornamentation with ± radiating vermiculate ridges on both faces, triradial mark distinct; widely distributed in tropical and northern Africa, Europe and N America, especially at alluvial sites ..... *R. frostii* (Figure 3A, B)
- 6b Thalli inflated to rather flat; usually becoming markedly cavernous; dorsally grooved along entire length or only apically; rarely in rosettes; green to straw-coloured or whitish, very rarely tinged with purple or red (section *Spongodes*, group 'Vesiculosa'):
- 12a Thalli large and very wide, 5.0–15.0 × 3.5–5.5(–8.0) mm; when dry, yellowish to straw-coloured or white; spores 100–150 (–160) µm in diam., with 8–12 areolae across distal face, wing 10 µm wide and thin:
- 13a Thalli straw-coloured when dry; deeply grooved along entire length; cavernous in older parts only; spores with areolae on distal face 10–15 µm wide ..... *R. bullosa* (Figure 3C, D)
- 13b Thalli white when dry; mostly only apically grooved; honeycomb-pitted dorsally; spores with areolae on both faces mostly wider than 10–15 µm, often up to 20 µm ..... *R. garsidei* (Figure 3E, F)
- 12b Thalli medium-sized and narrower, up to 12 × 2.5–3.0 mm; when dry, greyish white to yellowish; spores 88–112 µm in diam., with 5–8 areolae across distal face, wing not thin but 3–5 µm wide:
- 14a Thalli occasionally in rosettes; branches broadly ligulate to lingulate; antheridial necks inconspicuous, hyaline; widespread in summer rainfall areas of southern Africa ..... *R. volkii* (Figure 4A, B)
- 14b Thalli never in rosettes; branches somewhat linear; antheridia with conspicuous purple necks; very rare, only known from Knysna Dist. in the Western Cape ..... *R. rubricollis* (Figure 4C, D)
- 5b Thalli very thin and ± translucent; branches 10–15 times wider than thick; storage tissue vestigial; spores 40–65 µm in diam., apolar, globose, wingless, ornamentation with numerous small, low truncate spines or papillae (subgenus *Leptoriccia*) ..... *R. membranacea* (Figure 5E, F)
- 4b Spores remaining in tetrads (subgenus *Thallocarpus* with two species):
- 15a Thalli in complete or incomplete rosettes, 10–20 mm across; heterothallic, male plants once or twice furcate, very rarely in incomplete rosettes; branches small, 2.0 × 0.5 mm, occasionally larger; spores joined together by narrow band or ridge into tetrahedral tetrads, ornamentation with slender spinules up to 5 µm long ..... *R. curtisii* (Figure 6A, B)
- 15b Thalli reportedly in rosettes up to 11 mm across; male plants small; spores joined together by wide band into rhomboidal tetrads, ornamentation with stout spines, 10–15 µm long ..... *R. perssonii* (Figure 6C, D)
- 3b Thalli generally annual; mostly not in rosettes; terrestrial or occasionally aquatic; branches usually linear, strap-shaped or 'ribbon-like', 15–20 mm long and up to 2 mm wide, occasionally smaller; dorsally often tinged with violet, seldom lacunose; at times forming apical stolons; sporangia ventrally bulging markedly (section *Ricciella*):
- 16a Thalli monoicous:
- 17a Thalli sometimes aquatic; strap-shaped or ribbon-like; widespread in mostly summer rainfall areas of southern Africa and in tropical Africa; scales few, ventral, proximally split into 2, apically single; sporangia oblique; distal spore face with areolar walls thick and prominent, proximal spore face with distinct triradial mark ..... *R. stricta* (Figure 4E, F)
- 17b Thalli terrestrial; in small rosettes; branches narrow; ventral scales vestigial; dorsally somewhat lacunose proximally; sporangia vertical; spores with complete, regular areolae on both faces, proximal face lacking triradial mark; rare in tropical Africa, mostly in Europe and N America ..... *R. huebeneriana*\* (Figure 5A, B)
- 16b Thalli dioicous; terrestrial; linear, thin and lax; distribution restricted to winter rainfall area of the Western Cape; sporangia vertical; distal spore face with areolar walls thin, proximal face with distinct triradial mark ..... *R. purpurascens* (Figure 5C, D)

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- 2b Dorsal epidermis not with thin-walled, single-layered flat cells interrupted by air pores:
- 18a Dorsal epidermis devoid of cellular outgrowths, but with thick-walled cells, lacking chlorophyll; air pores surrounded by superimposed ring of smaller, thin-walled cells; thallus narrowly grooved, acutely winged; scales rounded, persistent, large, reaching thallus margins; spores single (subgenus *Chartacea*) ..... *R. schelpei* (Figure 6E, F)
- 18b Dorsal epidermis with cellular outgrowths of very tall, hair-like pillars; air pores surrounded by radially arranged wedge-shaped cells; thallus broadly grooved, obtusely winged; scales triangular, persistent, large, filamentous apices extending above thallus margins; spores remaining in globular to tetrahedral tetrads (subgenus *Pannosae*) ..... *R. tomentosa* (Figure 7A, B)
- 1b Thalli covered by a dorsal 'epithelium' of echlorophyllose cells in one or several strata; air pores numerous, small and regular intercellular spaces; assimilation tissue compact, in vertical rows of chlorophyllose cells separated by mostly very narrow interstitial air canals; ventral scales small to large; habitat often xeric, sometimes mesic; spores separating at maturity (subgenus *Riccia*):
- 19a Epithelial cells closely associated, in one or two layers, generally orientated regularly and in parallel rows running from median groove to margin; top cells globose, mammillose or pyriform, outer walls (or cells) often collapsing; scales small to large, rounded (section *Riccia*): (19b on p. 99)
- 20a Thalli with cilia along margins, occasionally also present over sporangia; ventral scales mostly not conspicuous; sometimes flanks dark purple (group 'Ciliatae'):
- 21a Thalli shortly or distinctly winged laterally; medium-sized to large, 7.0–30.0 × 2.5–10.0 mm; cilia short or long; spores straw-coloured or reddish brown:
- 22a Thalli shortly winged, medium-sized; branches 10–12 × 4 mm; cilia tapering, white when dry, up to 300(–400) × 30–50 µm at base, finely granular, absent over sporangia; spores straw-coloured, (95–)110–115 µm in diam., with wing 10 µm wide, slightly undulating; distribution restricted to southern Africa; hygrophyte ..... *R. natalensis* (Figure 7C, D)
- 22b Thalli distinctly winged, large; branches 7–30 × 2.5–10.0 mm; cilia 100–325 × 75–150 µm at base, hyaline and shiny; spores reddish brown, (130–)170–180(–215) µm in diam., with wing 9–10(–15) µm wide; widely distributed in the northern hemisphere ..... *R. gougetiana* (Figure 7E, F)
- 21b Thalli not winged laterally, smaller, less than 8.0 × 1.5 mm; cilia hyaline, dry or wet, long or short; spores brown to black, with or without wing; distribution widespread:
- 23a Distribution in southern Africa restricted to winter rainfall region of the Western Cape; hygrophyte; branches 3–6 × 1 mm; cilia generally quite sparse, 250(–400) µm long, finely granular, absent over sporangia; scales small, purple; flanks green; spores with wing ± 7.5 µm wide ..... *R. crozalsii* (Figure 8A, B)
- 23b Widespread in summer rainfall areas; xerophytes; cilia crowded, dense, variously long, not granular, present over sporangia; flanks dark purple; spores mostly wingless:
- 24a Thalli 5.0–6.0 × 0.9–1.5 mm; cilia straight to slightly flexuose, up to 950 µm long, smooth; spores 100–120 µm in diam., ornamentation reticulate, areolar walls heavily encrusted with papillae ..... *R. trichocarpa* (Figure 8C, D)
- 24b Thalli small, 1.0–4.0 × 0.6–0.8 mm; cilia arched, up to 300 µm long, channelled and finely striate; spores 80–90 µm in diam., ornamentation reticulate, areolar walls mostly smooth ..... *R. microciliata* (Figure 8E, F)
- 20b Thallus margins not ciliate, marginal cells enlarged or not; ventral scales small to large:
- 25a Thalli medium-sized; margins apically with row of mammillate cells up to 150 µm long; scales small, not extending to thallus margins, violet to hyaline; very rare (group 'Mammillatae') ..... *R. mammifera* (Figure 9A, B)
- 25b Thalli small to large; margins glabrous; scales larger, extending to margins or projecting above, hyaline or variously pigmented:
- 26a Scales not conspicuous, hyaline or partly hyaline; thallus margins hyaline; groove narrow and deep, persistent along most or whole length of thallus; dorsal epithelium sometimes with some cell walls thickened (group 'Squamatae'):
- 27a Dorsal epithelial and subepithelial cells always with markedly thicker walls; thalli light green, appearing almost waxy; margins not undulate; flanks green; spores polar, dark reddish brown to black, proximal face densely granulate; distribution widespread (nearly cosmopolitan) but apparently quite rare in tropical Africa ..... *R. sorocarpa* (Figure 9C, D)
- 27b Dorsal epithelial cells with walls rarely thicker; thalli glaucous green to bright green; margins undulate; flanks dark red-brown or violet; spores almost apolar or polar, dull dark brown to nearly black, reticulate:
- 28a Thalli large; apices rounded; margins usually strongly and irregularly undulate, overhanging in cross section; spores 110–125 µm in diam., triangular-globular, polar, not winged, uniformly reticulate on both faces, ± 7 areolae across distal face, 15–20 µm wide, triradial mark on proximal face indistinct; plants rare ..... *R. nigerica* (Figure 9E, F)
- 28b Thalli medium-sized or smallish; apices tapering to obtusely rounded; margins not strongly undulate, not overhanging in cross section, but flanks rising ± steeply, to slightly obliquely; spores smaller, 75–105 µm in diam.:
- 29a Thallus flanks not appearing vertically 'striped'; spores almost apolar, subglobular, wingless, proximal face without triradial mark, ornamentation on 2 faces similar, distal face with 10–12(–14) areolae across, 7.5–12.5 µm wide ..... *R. atropurpurea* (Figure 10A, B)
- 29b Thallus flanks often appearing vertically 'striped' due to hyaline margins of scales above purple bases; spores polar, triangular-globular, winged, proximal face with triradial mark distinct:
- 30a Thalli medium-sized; branches up to 2.5 mm wide; spores with 2 faces dissimilar, facets on proximal face almost smooth or with poorly developed areolar walls, distal face with (5)6–8 areolae across the diam., (10–)12–22 µm wide, but areolae often incomplete, areolar walls up to 5 µm high ..... *R. lanceolata* (Figure 10C, D)
- 30b Thalli smallish; branches 1.0–1.5 mm wide; repeatedly furcate; spores with 2 faces similar or dissimilar:
- 31a Spores with 2 faces similar, distal face with 8 or 9 areolae across the diam., 13–15 µm wide, areolar walls sometimes ± incomplete, rather thick and raised at nodes into sharply truncate, plate-like papillae, 3–5 µm high ..... *R. radicata* (Figure 10E, F)
- 31b Spores with 2 faces dissimilar, distal face with central areolae ± 10 µm wide, decreasing in size toward margins, proximal face with numerous small areolae, ± 2.5 µm wide, on each facet ..... *R. schweinfurthii* (Figure 11A, B)
- 26b Scales often large and conspicuous, pigmented, with or without hyaline border or entirely hyaline to white; groove various; dorsal epithelial cell walls not thickened:
- 32a Scales dark, black or reddish black to deep violet, shiny; thallus size variable; dorsally glaucous green to green or purplish, rarely brown:
- 33a Thalli medium-sized to large; in section 2.5–5.0 times wider than thick; flanks sloping obliquely:
- 34a Thalli large, up to 15 × 5 mm; margins winged, overhanging; spores subglobular, apolar, ornamentation reticulate with thin, high areolar walls ..... *R. congoana* (Figure 11C, D)
- 34b Thalli medium-sized to large, up to 15 × 2(–4) mm; margins attenuate, not overhanging; spores triangular-globular, polar, areolar walls thick, low:
- 35a Distribution restricted to winter rainfall regions of Western and Northern Cape; thalli quite fleshy; scales imbricate, clasped together along midline when dry; spores 90–125 µm in diam., distal face with short spiralling ridges, proximal face almost smooth, with scattered pores ..... *R. limbata* (Figure 11E, F)
- 35b Distribution widespread in summer rainfall regions, but not common; thalli mostly thinner; scales imbricate to proximally more widely spaced; when dry, opposite scales meeting or not, never clasped together; spores 72–82 µm in diam., distal face with areolae in more or less concentric rings, proximal face completely or incompletely reticulate ..... *R. angolensis* (Figure 12A, B)



- 33b Thalli smallish to medium-sized; in section 1–2 times wider than thick; flanks steeply rising:
- 36a Thalli medium-sized; bluish green; scales projecting above thallus margins, edge crenate, rather dull black, dry; spores golden brown, wingless, densely papillate ..... *R. okahandjana* (Figure 12C, D)
- 36b Thalli smallish; glaucous green, rust-brown along margins and proximally; scales appressed, not projecting above thallus margins, edge smooth, shiny dry or wet; spores light brown to dark brown, winged, incompletely reticulate ..... *R. nigrella* (Figure 12E, F)
- 32b Scales other than black, variously coloured or white; thalli small to medium-sized; dorsally green to yellow-green, white or brownish:
- 37a Scales brown or various shades of red, pink or violet:
- 38a Thallus margins and scales brownish yellow; idioblasts (enlarged cells with brown contents) present throughout thallus; spores vermiculate; species very rare in sub-Saharan Africa ..... *R. macrocarpa* (Figure 13A, B)
- 38b Thallus margins not brown; scales dark red or pink or violet; idioblasts absent; spores reticulate:
- 39a Thalli very small, 1.5–2.5(–3.0) × 0.7–1.0 mm; bottle-green, tumid; scales regular, appressed, dark red, white-bordered; spores 60–78 µm in diam., triangular-globular, polar; distribution restricted to Free State and Eastern Cape ..... *R. pottsiana* (Figure 13C, D)
- 39b Thalli medium-sized to robust; bright green or light green to whitish, sometimes tinged with red or violet; scales purple-red, wine-red or cherry-red to rose-pink, exceptionally not persistent; spores 75–125(–140) µm in diam., mostly globular to subglobular, apolar, rarely triangular-globular and polar; widespread or rare:
- 40a Thalli with assimilation tissue containing somewhat wider than usual air canals toward margins; if in rosettes these are irregular; thallus margins parallel or subparallel; spores always apolar:
- 41a Thalli robust, up to 12 mm long; not in rosettes; scales smallish, pink-red to violet, distant; perennating by apical stolons; spores globular, apolar, 90–110(–135) µm in diam., areolae 12–15(–18) µm wide, lacking spines at nodes ..... *R. discolor* (Figure 13E, F)
- 41b Thalli smallish, up to 5 mm long; in irregular rosettes; scales not persistent; not perennating by stolons; spores globular, apolar, 80–90(–95) µm in diam., areolae 12–15 µm wide, at nodes truncate spines 4–8 µm high ..... *R. symoensii* (Figure 14A, B)
- 40b Thalli with assimilation tissue containing narrow air canals throughout; rarely in incomplete rosettes; thallus margins generally tapering toward apex; spores mostly apolar, only exceptionally polar:
- 42a Thalli up to 8.5 × 1.5–2.0 mm, light green; scales purplish red to deep cherry-red, lacking hyaline border and only slightly projecting above thallus margins, imbricate; spores triangular-globular, polar, both faces ornamented with tiny areolae ..... *R. erubescens* (Figure 14C, D)
- 42b Thalli 6–12 × 1–4 mm; green, turning grey-green, or not, or pale green and white along margins or light bluish green, becoming violet or brownish grey with age; scales dark red or rose-pink or purple, with or without hyaline border; spores apolar:
- 43a Thalli 7.0–12.0 × 1.0–2.5 mm; bright green, turning grey-green or pale green and white along margins; scales dark red or rose-pink, with narrow or wide hyaline border:
- 44a Thalli 7.0–9.0 × 1.2–1.6 mm; bright green, turning grey-green; scales dark red, shiny, with narrow hyaline border; monoicous; spores ruby-red to black, (80–)85–105 (–110) µm in diam., subglobular, (6–)8–10 areolae across spore face, 10.0–12.5 µm wide, periphery with prominent projections, up to 7.5 µm long, appearing cogwheel-like in profile ..... *R. runssorensis* (Figure 14E, F)
- 44b Thalli up to 12.0 × 1.0–2.5 mm; pale green, along margins white; scales wavy, rose-pink with wide hyaline border; dioicous; spores rare, light brown, periphery with low projections ..... *R. rosea* (Figure 15A, B)
- 43b Thalli 6–12 × 2–4 mm; light bluish green, turning violet to brownish grey with age, or green; scales purple-red or dark red to purple, without hyaline border:
- 45a Thalli up to 12 × 2–4 mm; light bluish green, becoming violet to brownish grey with age; in section 2–2½ times wider than thick; scales purple-red, projecting slightly beyond thallus margins; spores 70–80 µm in diam., dark red, margin with numerous low, blunt projections ..... *R. saharensis* (Figure 23C, D)
- 45b Thalli 6–7 × 2–3 mm; green; in section up to 7 times wider than thick; scales dark red to purple, shiny, inserted beneath thallus wings and projecting slightly beyond margins; spores 92.5–105.0 µm in diam., dark red to almost black, marginal papillae ± 5 µm high ..... *R. papillisporea* (Figure 23E, F)
- 37b Scales predominantly hyaline or white, wavy or appressed; thalli without or with calcium deposits:
- 46a Thalli and scales lacking calcium deposits:
- 47a Thalli up to 7.0 × 1.3–1.8 mm, white-green to blue-green; dioicous; antheridial necks conspicuous, up to 250 µm long; spores deep red-brown, wingless, (105–)115–125 µm in diam., with 11 areolae across distal face; very rare species ..... *R. somaliensis* (Figure 15C, D)
- 47b Thalli 5–15 × 2–4 mm, light grey-green; monoicous; antheridial necks inconspicuous, 60–85 µm long; spores dark brown, narrowly winged or wingless, (75–)90–120(–125) µm in diam., with up to 10 areolae across distal face; widespread species ..... *R. lamellosa* (Figure 15E, F)
- 46b Thalli and scales with calcium deposits:
- 48a Scales large, 850–1250 × 500–750 µm, irregularly wavy to frilly, closely imbricate; thalli mostly 8.0–9.0(–12.0) × 1.5–2.0 (–4.0) mm; apically grooved; dorsally green, turning white and spongy over sporangia:
- 49a Thalli in rosettes or gregarious; widespread and quite common; spores with 10–12 round to angular areolae across diam. of distal face ..... *R. albolimbata* (Figure 16A, B)
- 49b Thalli not in rosettes; spores with 14–20 small deep areolae across diam. of distal face; quite rare, distribution apparently restricted to Northern Cape ..... *R. albornata* (Figure 16C, D)
- 48b Scales rather smaller, up to 850 × 500 µm, mostly appressed and regular, imbricate; thalli generally slightly smaller, 7.0–8.0(–12.0) × 0.7–2.0(–4.0) mm; apically grooved or along almost the entire length; dorsally dull or shiny:
- 50a Thalli deeply grooved along most of entire length; dioicous; spores apolar or polar:
- 51a Thalli dorsally dull grey-green, compact; dorsal epithelial cells often rather thick-walled; air pores triangular or quadrangular; scales regular, appressed, base purple-grey; spores apolar, wingless; fairly widespread ..... *R. argenteolimbata* (Figure 16E, F)
- 51b Thalli dorsally glistening, light green to green; finely spongy; dorsal epithelial cells thin-walled, not in regular pattern; scales apically wavy, soon appressed; spores polar, winged; distribution restricted to eastern mountainous regions of southern Africa ..... *R. montana* (Figure 17A, B)

\* In Jones's (1957) opinion, *R. runssorensis* Steph. and *R. papillisporea* Steph. are closely allied plants and judging from the portions of the types that he had seen, they may be identical. I, however, regard them as different species, the scales of *R. papillisporea* lack a hyaline border and its spores have shorter papillae, as noted by Jones.



- 50b Thalli only apically grooved; monoicous; spores polar:
- 52a Thalli with wide, shallow groove, 8 × 4 mm, dorsally very heavily encrusted with calcium deposits; air pores large, regular; scales white; spores finely reticulate . . . . . *R. alboborosa* (Figure 17C, D)
- 52b Thalli narrowly grooved, up to 5 × 1–2 mm, dorsally with fine calcium deposits; air pores small to large, irregular; scales bicoloured, with deep purple base; spores more coarsely reticulate . . . . . *R. bicolorata* (Figure 17E, F)
- 19b Epithelial cells in free-standing 2–5(6)-celled, uniseriate pillars, irregularly orientated; top cells variously shaped, soon collapsing; scales small to large, mostly rounded and smooth-margined, rarely triangular and dentate or apically filiform (section *Pilifer*):
- 53a Dorsal pillars short, often less than 200 µm long, consisting of 2 or 3(4) cells, mostly wider than long, tapering or not tapering:
- 54a Dorsal pillars tapering; air canals up to 100 µm wide:
- 55a Spores wide-winged, wing up to 10 µm wide, elaborately ornamented; very rarely found: . . . . . *R. hantamensis* (Figure 18A, B)
- 56a Thalli large, up to 10.0 × 2.5–3.8 mm; scales hyaline . . . . . *R. alatospora* (Figure 18C, D)
- 56b Thalli small, up to 5.0 × 0.9–1.5(–2.0) mm; scales red . . . . . *R. alboborosa* (Figure 18C, D)
- 55b Spores narrow-winged, wing up to 5 µm wide; ornamentation less elaborate, especially on proximal face, where often reduced to simple projections and stipplings; widespread . . . . . *R. alboborosa* (Figure 18E, F)
- 54b Dorsal pillars not tapering; air canals narrow:
- 57a Thalli quite large, up to 10 × 3–4 mm; broadly ovate to obovate; in section 3–4 times wider than thick; flanks sloping obliquely; distal spore face with 10–14 areolae across diam., sometimes with central papilla or short radiating ridges . . . . . *R. concava* (Figure 19A, B)
- 57b Thalli smaller, up to 8 × 1–2 mm; ligulate to ovate; in section as wide as, to twice wider than thick; flanks steep; spores variously ornamented:
- 58a Branches frequently simple, long and narrow; spore distal face with 5–7 large, incomplete areolae across diam., often with central boss . . . . . *R. elongata* (Figure 19C, D)
- 58b Branches mostly several times furcate; spore distal face with more than 7 smaller areolae across diam., lacking central boss:
- 59a Branches apically keeled to wedge-shaped; margins somewhat tumid; dorsal cell pillars up to 180 µm long; proximal spore face reticulate:
- 60a Dorsal pillars with top cell mammillose; distal spore face with ridges generally forming a central cross; distribution restricted to Western and Northern Cape . . . . . *R. furfuracea* (Figure 19E, F)
- 60b Dorsal pillars with top cell globose; distal spore face with ± 8 angular, irregular areolae across diam.; distribution apparently restricted to Lesotho . . . . . *R. trachyglossum* (Figure 20A, B)
- 59b Branches apically rounded; margins not tumid; dorsal cell pillars only 70–105 µm long; proximal spore face granulate . . . . . *R. pulveracea* (Figure 20C, D)
- 53b Dorsal pillars tall, longer than 200 µm and up to ± 450 µm (rarely 1000 µm) long, consisting of (3)4–6 narrow, elongated cells, (1½)–2–3 (or more) times longer than wide:
- 61a Dorsal surface of thallus generally somewhat velvety or furry when fresh; emerald-green to lighter green; pillars gradually tapering to narrower apical cell:
- 62a Scales rounded, wavy, large, 1500 × 600–900 µm, margin smooth; thallus emerald-green; basal cells of pillars almost equally long, walls somewhat thickened; spores polar, ornamentation finely or coarsely reticulate . . . . . *R. simii* (Figure 20E, F)
- 62b Scales triangular, very large, up to 1800 µm long; basal cells of pillars variably long, walls not thickened; spores variously ornamented:
- 63a Triangular scales with dentate margins; dorsal pillars up to 450 µm long; spores papillose; not rare, but distribution restricted to the Northern and Western Cape . . . . . *R. villosa* (Figure 21A, B)
- 63b Triangular scales with filamentous apices; dorsal pillars up to 1000 µm long; spore ornamentation incompletely reticulate; very rare . . . . . *R. hirsuta* (Figure 21C, D)
- 61b Dorsal surface of thallus rarely velvety or furry; steel-grey to bright green or olivaceous green; cell pillars not, or hardly tapering:
- 64a Dorsally steel-grey; dorsal pillars tall (up to 450 µm long), like slivers of glass, often interlocking over groove; thalli larger, up to 9 mm long; scales large and billowing, basal cell walls appearing 'stretched'; proximal spore face incompletely reticulate and granulate, distal face with a few short, well-spaced, radiating, central ridges . . . . . *R. vitrea* (Figure 21E, F)
- 64b Dorsally olivaceous green or crystalline; dorsal pillars shorter (mostly less than 350 µm long), not interlocking, or if so, only temporarily toward apex; thalli mostly less than 8 mm long; scales smaller and not billowing; spore ornamentation completely reticulate on proximal face, not granulate, distal face reticulate or with several, long, thick, radiating ridges:
- 65a Dried thalli with brown, parchment-like flanks, proximally almost without scales; wet thalli velvety, olivaceous green; distal spore face with thick radiating ridges . . . . . *R. albomarginata* (Figure 22A, B)
- 65b Dried thalli frequently with somewhat purple flanks; wet thalli rather crystalline, bright green or purplish green:
- 66a Thalli in section 1.5 times to nearly twice wider than thick; sides tightly inflexed when dry . . . . . *R. namaquensis* (Figure 22C, D)
- 66b Thalli in section 2–4 times wider than thick; sides incurved when dry:
- 67a Cells in dorsal pillars mostly somewhat constricted in middle, ampulla-shaped; spores 90–95(–105) µm in diam., distal face with several radiating ridges; distribution restricted to eastern mountains in southern Africa . . . . . *R. ampullacea* (Figure 22E, F)
- 67b Cells in dorsal pillars not constricted; spores 70–80(–90) µm in diam., ornamentation with numerous small areolae; distribution restricted to Western Cape . . . . . *R. parvo-areolata* (Figure 23A, B)

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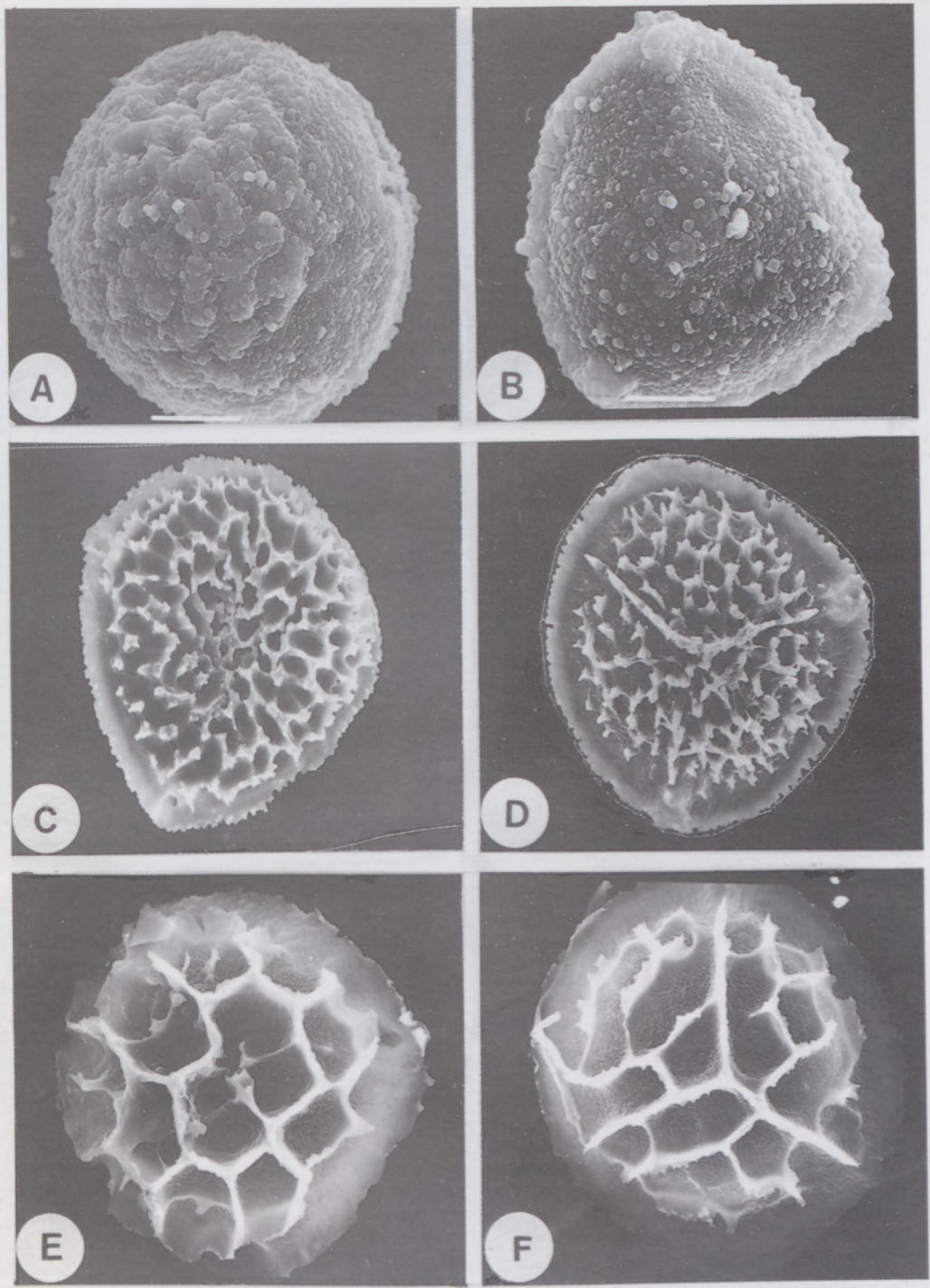


FIGURE 1.—SEM micrographs of spores. A, B, *Ricciocarpus natans*: A, distal face; B, proximal face. C, D, *Riccia crystallina*: C, distal face; D, proximal face. E, F, *R. vulcanicola*: E, distal face; F, proximal face. A, B, Ward s.n.; C, D, Duthie 5313 (BOL); E, F, Pócs 8068/158. A–D,  $\times 800$ ; E, F,  $\times 700$ .



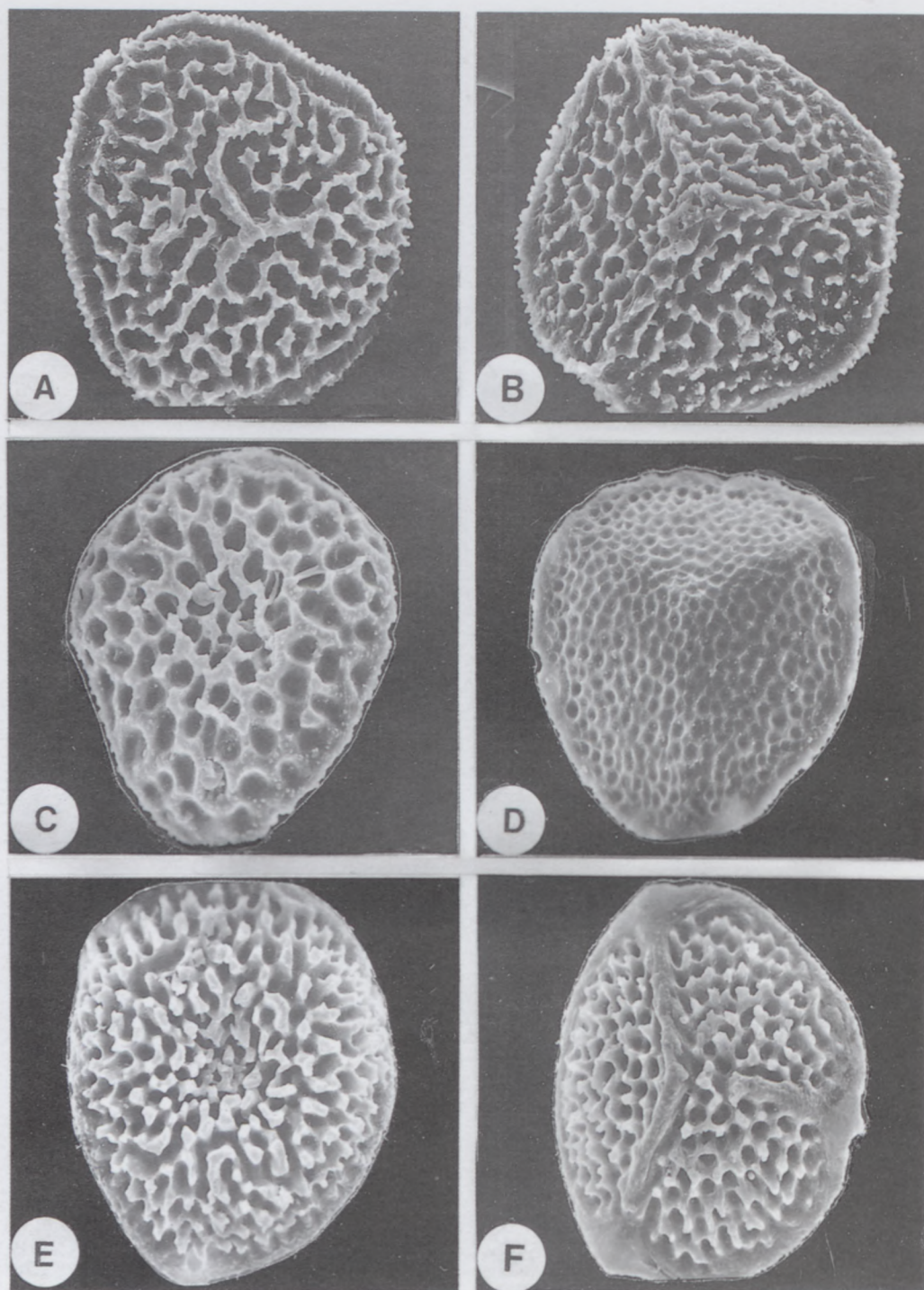


FIGURE 2.—SEM micrographs of spores. A, B, *Riccia cavernosa*: A, distal face; B, proximal face. C, D, *R. moenkemeyeri*: C, distal face; D, proximal face. E, F, *R. cupulifera*: E, distal face; F, proximal face. A, B, *Shearing 178*; C, D, *T.R. Sim 9072*; E, F, *Duthie 7471*. A–F,  $\times 800$ .



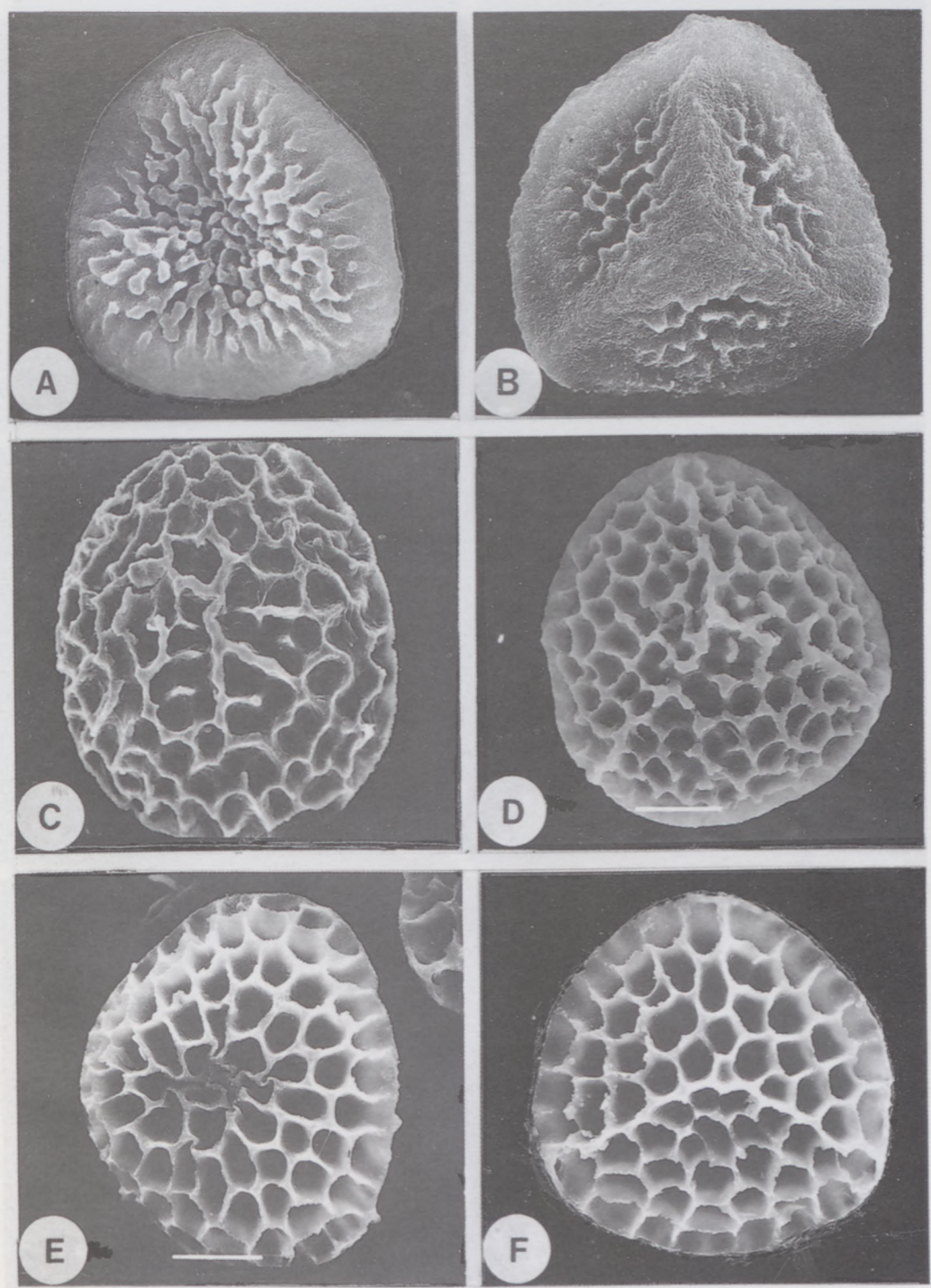


FIGURE 3.—SEM micrographs of spores. A, B, *Riccia frostii*: A, distal face; B, proximal face. C, D, *R. bullosa*: C, distal face; D, proximal face. E, F, *R. garsidei*: E, distal face; F, proximal face. A, B, *Monod 10537* (PC); C, *Duthie 5486a*; D, *S.M. Perold 467*; E, F, *S.M. Perold 536*. A,  $\times 800$ ; B,  $\times 900$ ; C,  $\times 600$ ; D–F,  $\times 500$ .



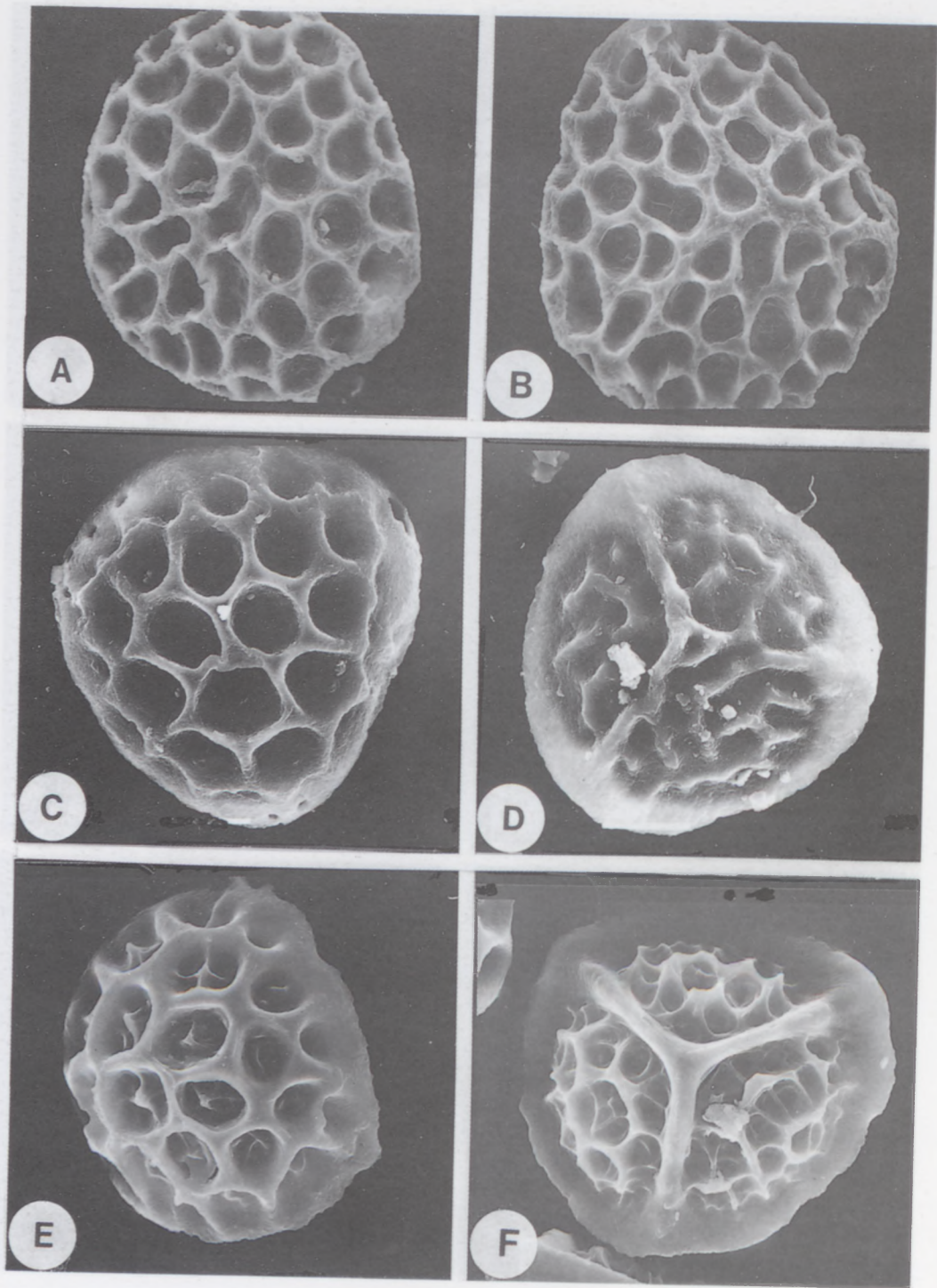


FIGURE 4.—SEM micrographs of spores. A, B, *Riccia volkii*: A, distal face; B, proximal face. C, D, *R. rubricollis*: C, distal face; D, proximal face. E, F, *R. stricta*: E, distal face; F, proximal face. A, B, Volk 81/230; C, D, Duthie 5014; E, F, M. Koekemoer 988. A, B, E, F,  $\times 700$ ; C, D,  $\times 600$ .



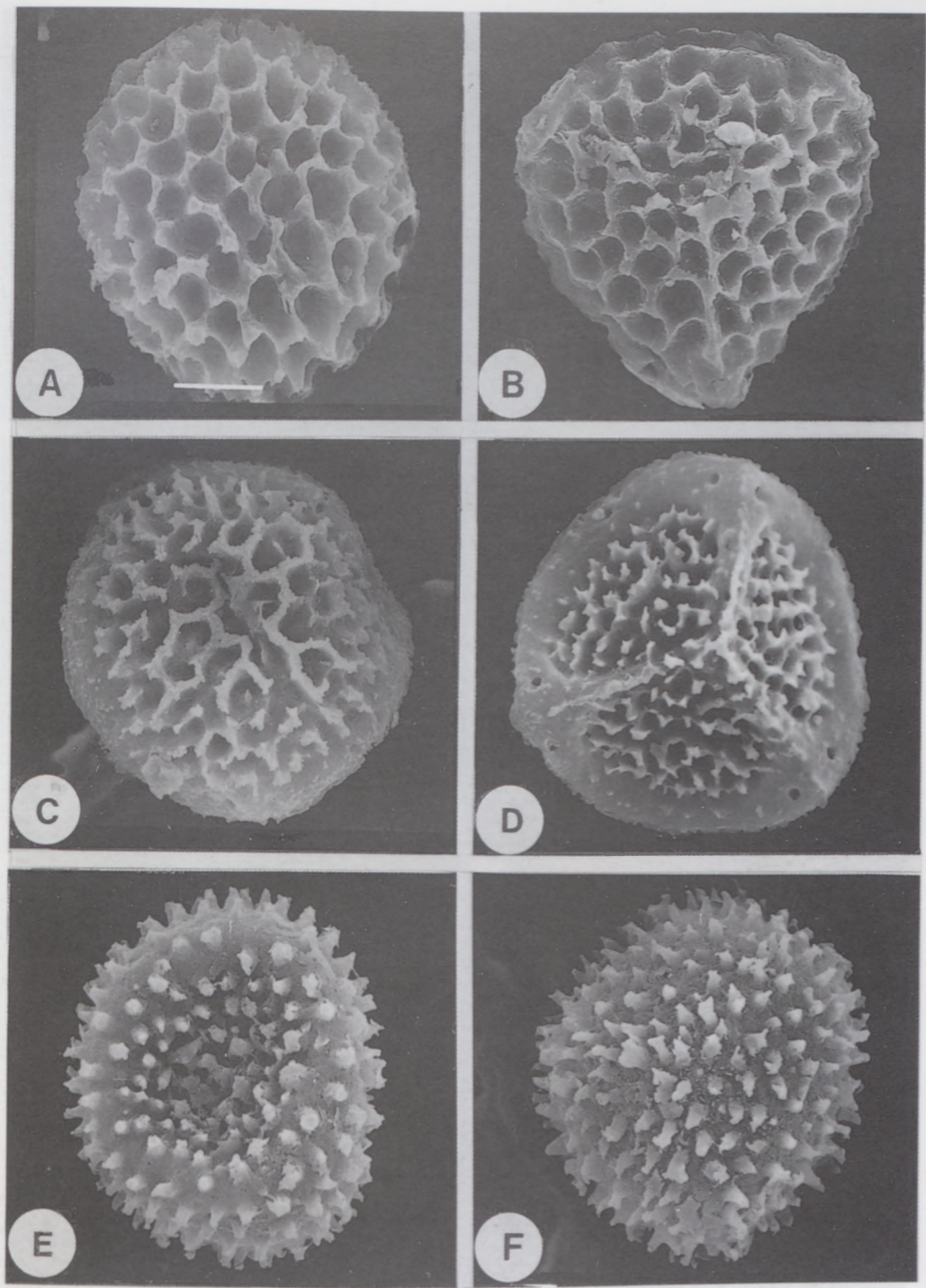


FIGURE 5.—SEM micrographs of spores. A, B, *Riccia huebeneriana*: A, distal face; B, proximal face. C, D, *R. purpurascens*: C, distal face; D, proximal face. E, F, *R. membranacea*: E, distal face; F, proximal face. A, B, Lübenau-Nestlé s.n.; C, D, MacLoughlin CH4197; E, F, Jones 672 (BM). A, B,  $\times 750$ ; C, D,  $\times 650$ ; E, F,  $\times 870$ .



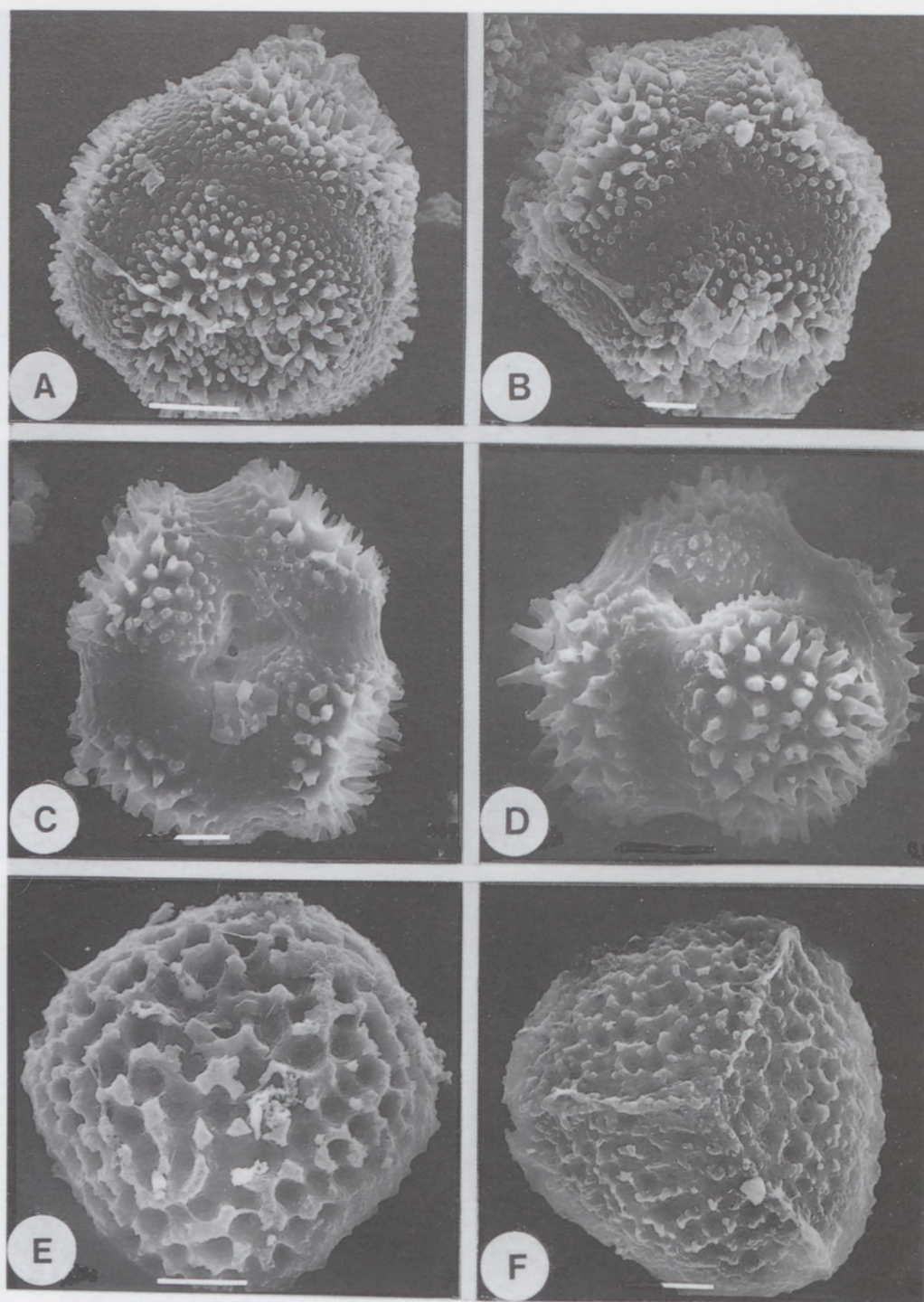


FIGURE 6.—SEM micrographs of spores. A, B, *Riccia curtisii*: A, B, tetrads. C, D, *R. perssonii*: tetrads. E, F, *R. schelpei*: E, distal face; F, proximal face. A, B, *S.M. Perold* 2730; C, D, *Volk* 2059; E, F, *C.M. van Wyk* 2524. A–D, F,  $\times 600$ ; E,  $\times 550$ .



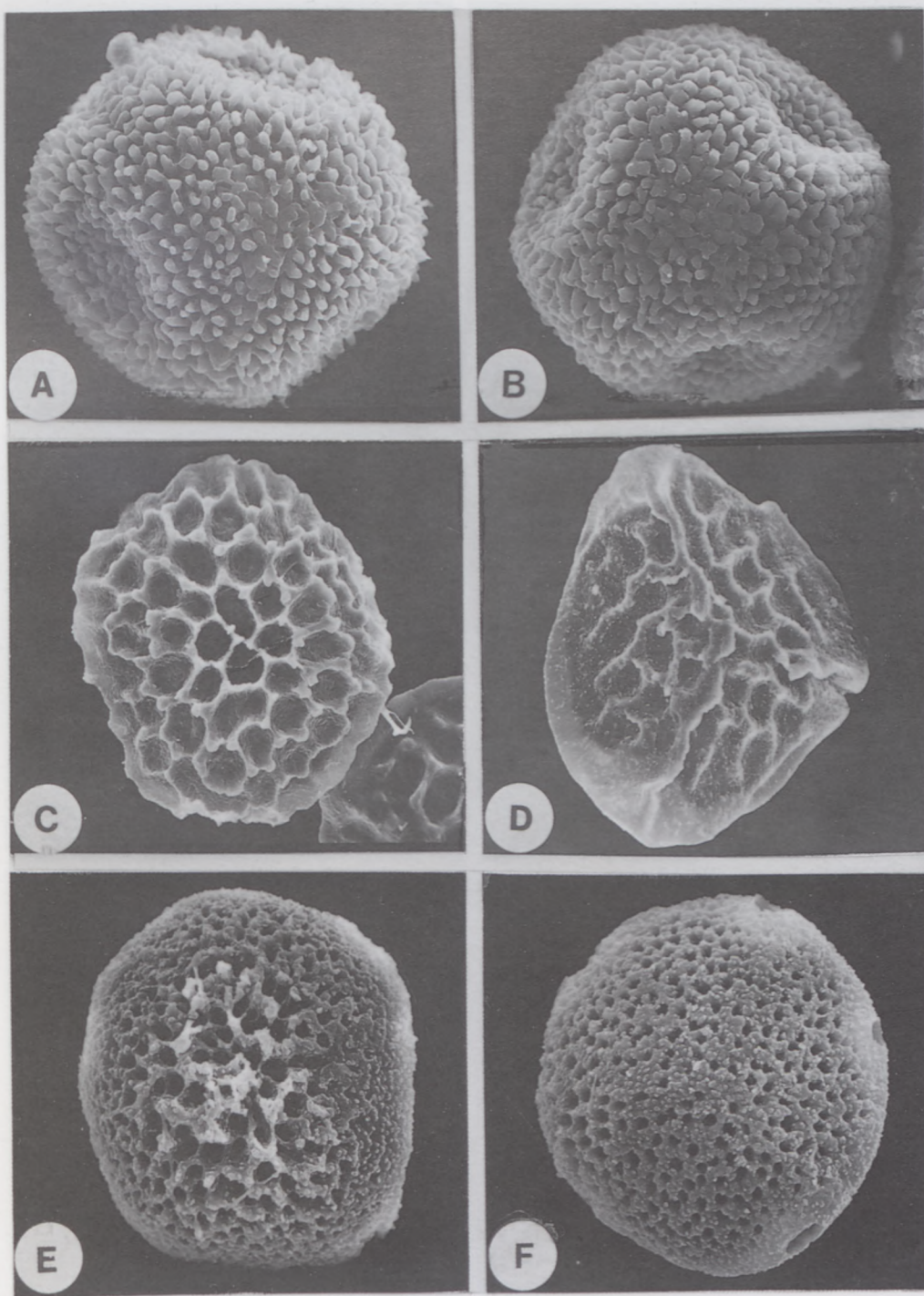


FIGURE 7.—SEM micrographs of spores. A, B, *Riccia tomentosa*: tetrads. C, D, *R. natalensis*: C, distal face; D, proximal face. E, F, *R. gougetiana*: E, distal face; F, proximal face. A, B, *S.M. Perold* 1495; C, *S.M. Perold* 307; D, *T.R. Sim* 8228; E, F, *Volk* 82/980 (Herb. Volk). A–D,  $\times 600$ ; E, F,  $\times 400$ .



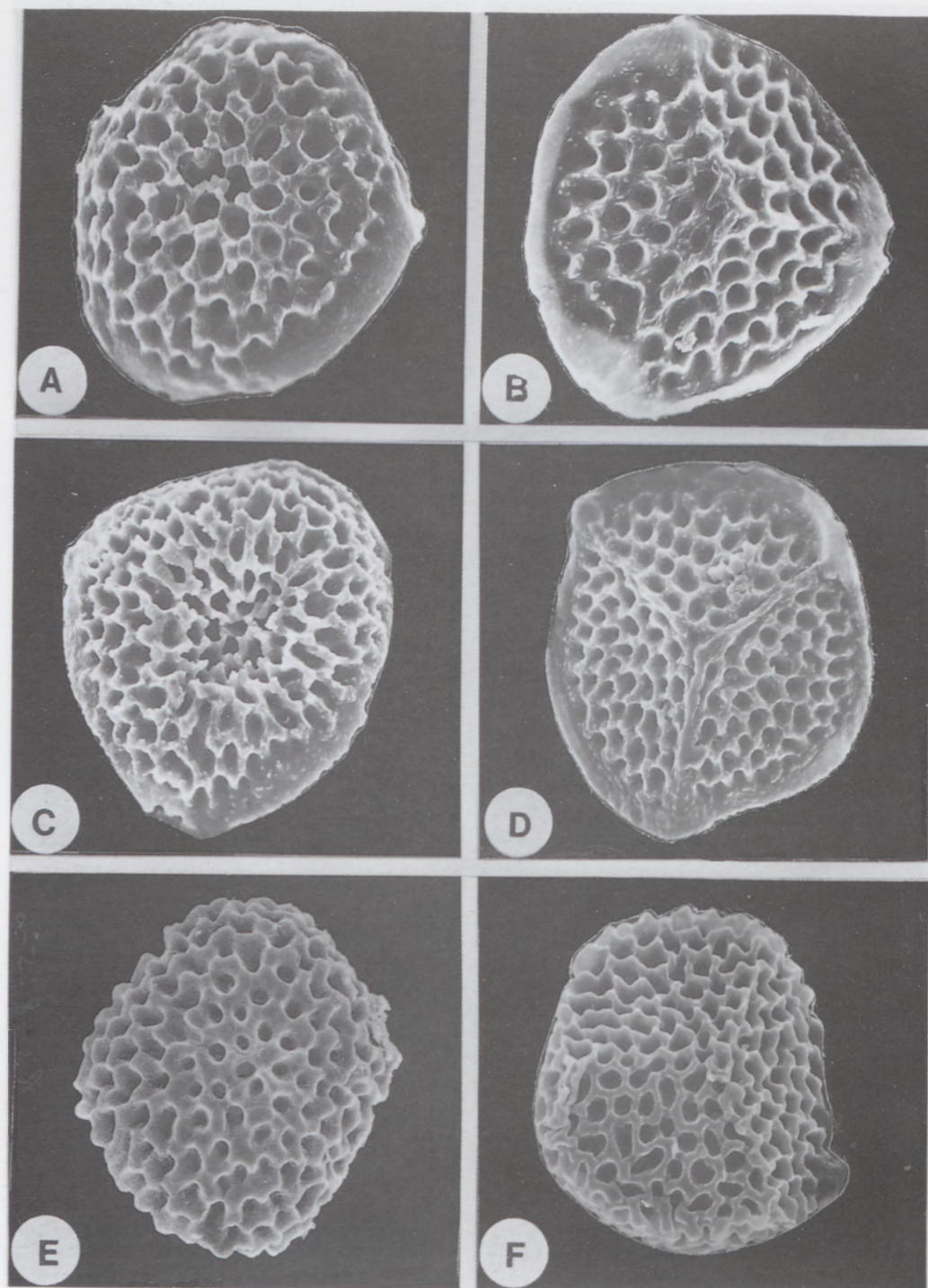


FIGURE 8.—SEM micrographs of spores. A, B, *Riccia crozalsii*: A, distal face; B, proximal face. C, D, *R. trichocarpa*: C, distal face; D, proximal face. E, F, *R. microciliata*: E, distal face; F, proximal face. A, *Duthie 5436a* (BOL); B, *Malherbe & Davies 5373* (BOL); C, D, *Toelken 5561*; E, F, *S.M. Perold 102*. A–F,  $\times 800$ .



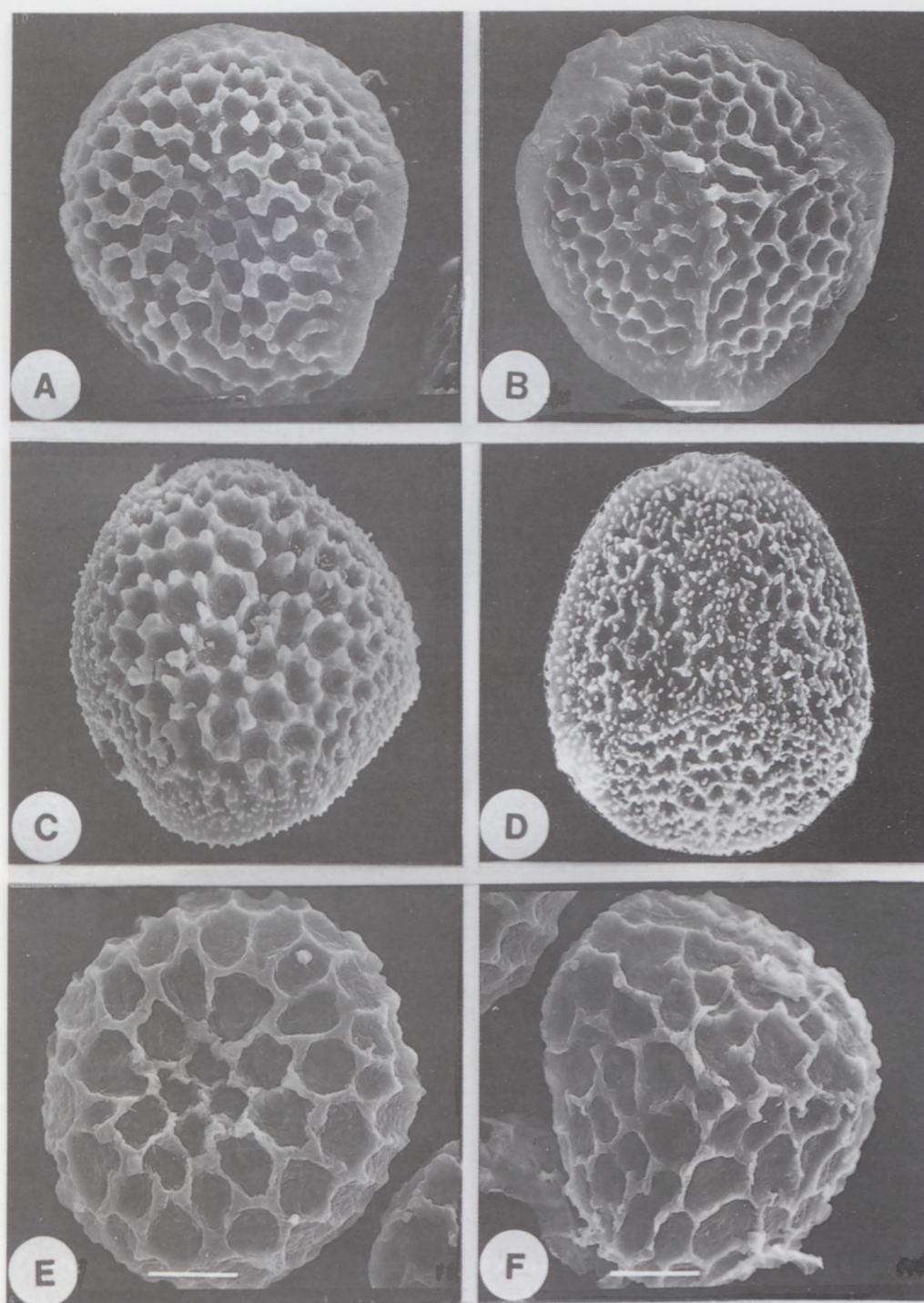


FIGURE 9.—SEM micrographs of spores. A, B, *Riccia mammifera*: A, distal face; B, proximal face. C, D, *R. sorocarpa*: C, distal face; D, proximal face. E, F, *R. nigerica*: E, distal face; F, proximal face. A, B, *S.M. Perold* 447; C, D, *S.W. Arnell* 303; E, F, *Jones* 1167 (BM). A, B,  $\times 600$ ; C, D,  $\times 800$ ; E, F,  $\times 400$ .



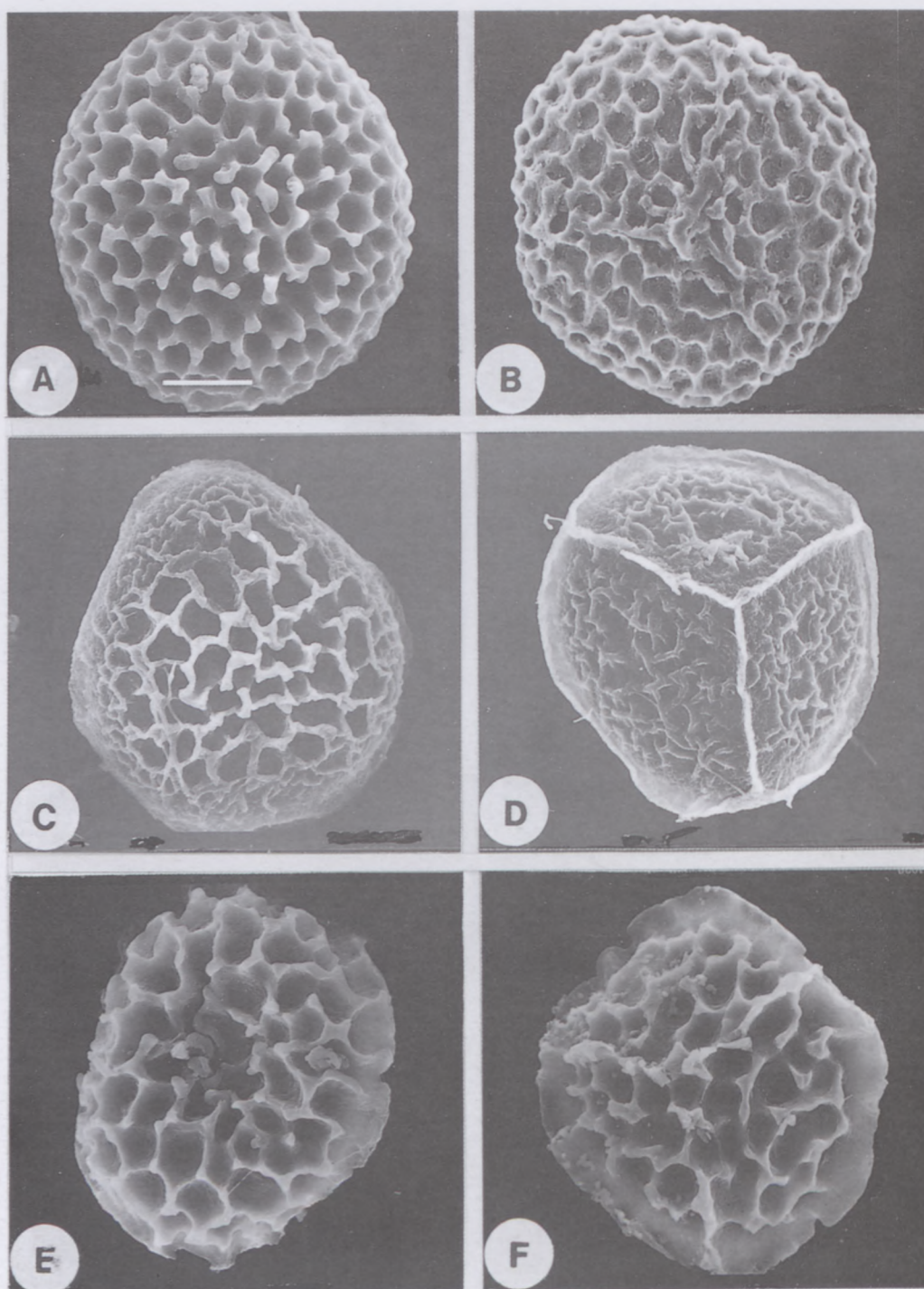


FIGURE 10.—SEM micrographs of spores. A, B, *Riccia atropurpurea*: A, distal face; B, proximal face. C, D, *R. lanceolata*: C, distal face; D, proximal face. E, F, *R. radicata*: E, distal face; F, proximal face. A, S.M. Perold 782b; B, Volk 84/710; C, D, Porembski & Biedinger 1313; E, F, Vanderyst s.n. (BR). A, B,  $\times 600$ ; C, D,  $\times 450$ ; E, F,  $\times 500$ .



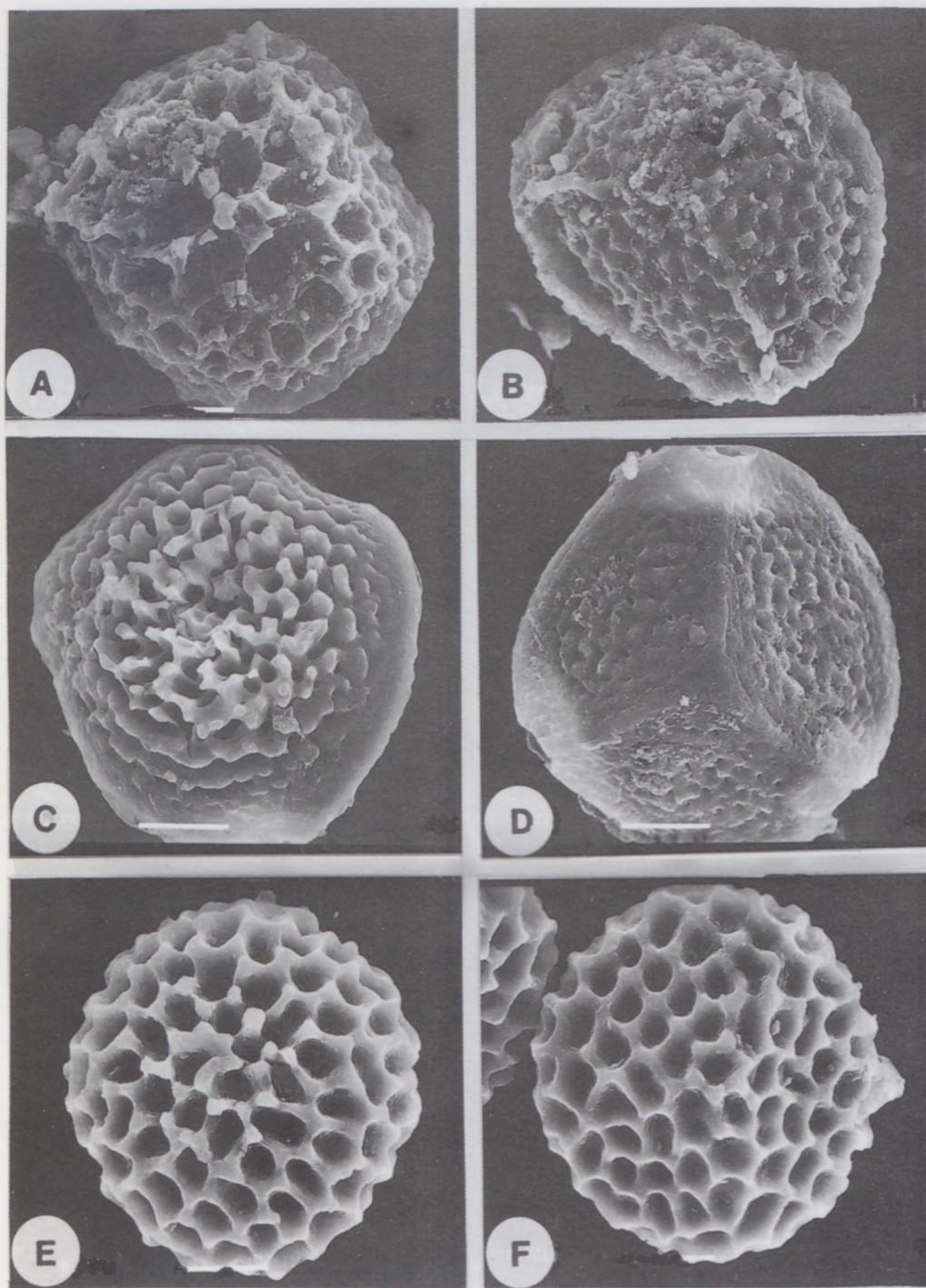


FIGURE 11.—SEM micrographs of spores. A, B, *Riccia schweinfurthii*: A, distal face; B, proximal face. C, D, *R. congoana*: C, distal face; D, proximal face. E, F, *R. limbata*: E, distal face; F, proximal face. A, B, *Schweinfurth 1832* (H); C, D, *Volk 00747a*; E, F, *Oliver 8858*. A–D,  $\times 450$ ; E, F,  $\times 600$ .



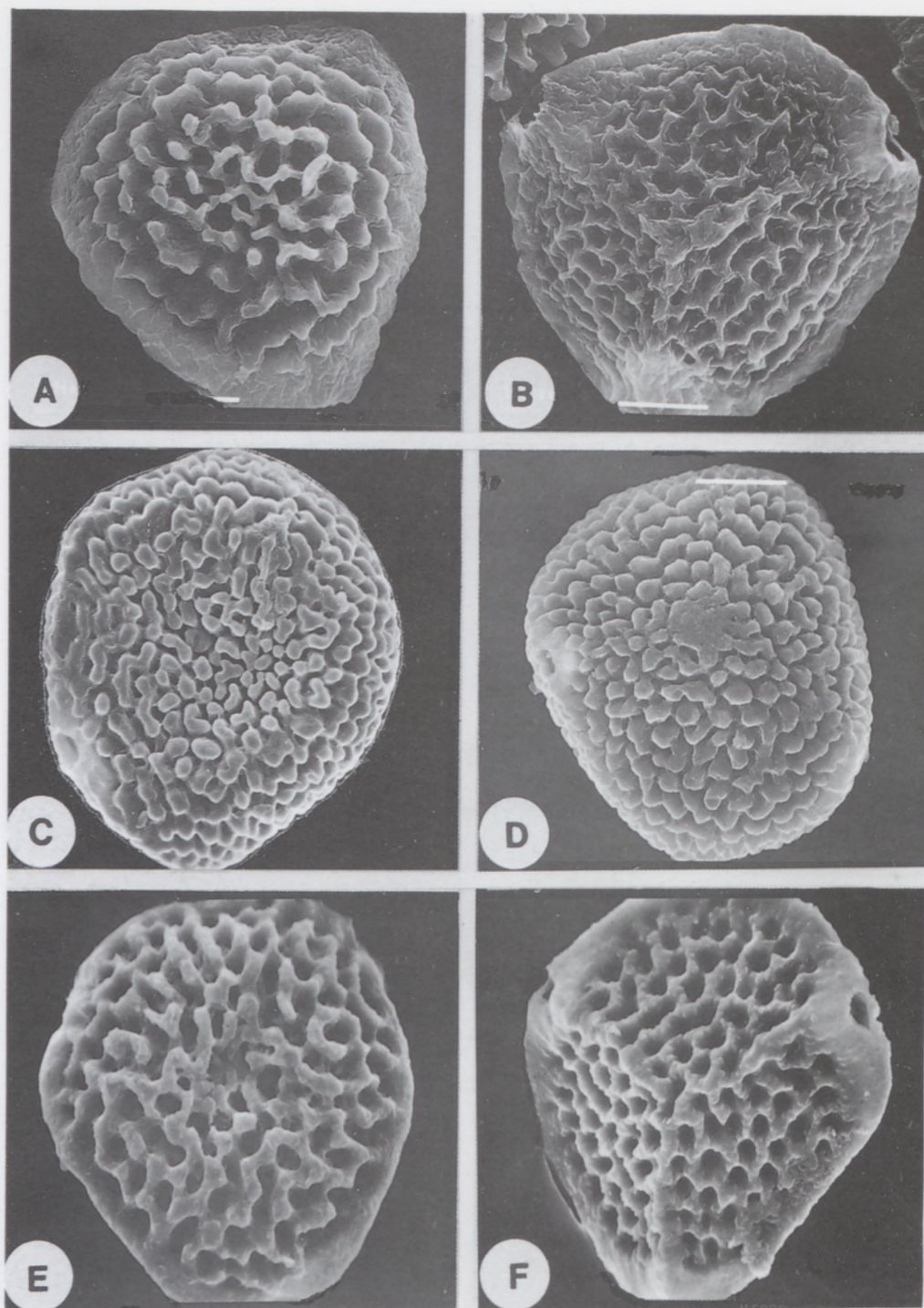


FIGURE 12.—SEM micrographs of spores. A, B, *Riccia angolensis*: A, distal face; B, proximal face. C, D, *R. okahandjana*: C, distal face; D, proximal face. E, F, *R. nigrella*: E, distal face; F, proximal face. A, B, *S.M. Perold* 2466a; C, *S.M. Perold* 267; D, *Volk* 84/707; E, F, *S.M. Perold* 1147. A–D,  $\times 600$ ; E, F,  $\times 800$ .



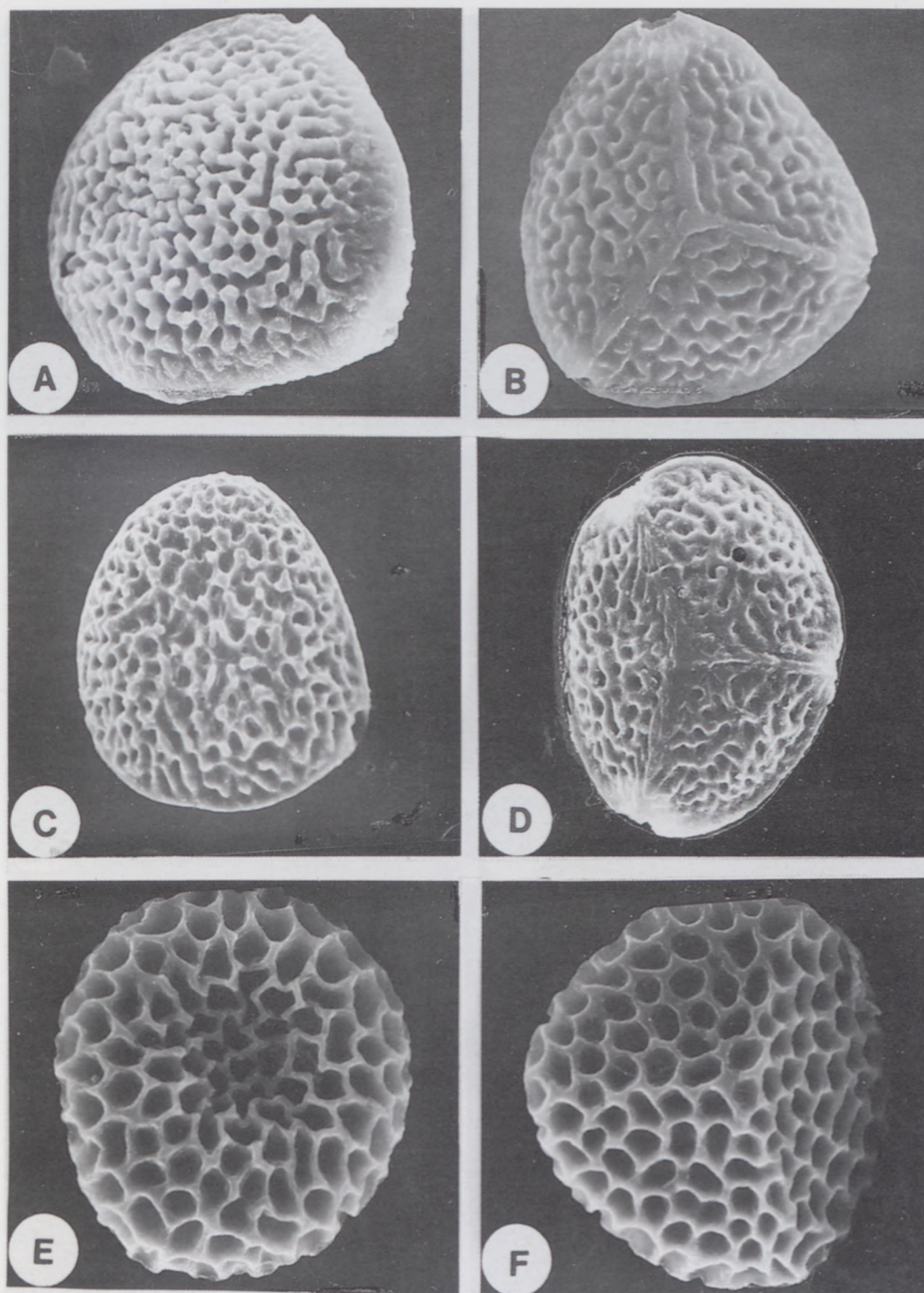


FIGURE 13.—SEM micrographs of spores. A, B, *Riccia macrocarpa*: A, distal face; B, proximal face. C, D, *R. pottsiana*: C, distal face; D, proximal face. E, F, *R. discolor*: E, distal face; F, proximal face. A, B, *S.M. Perold* 888; C, D, *Duthie* 5463a (BOL); E, F, *Bingham* 8108. A, B,  $\times 700$ ; C, D,  $\times 800$ ; E, F,  $\times 600$ .



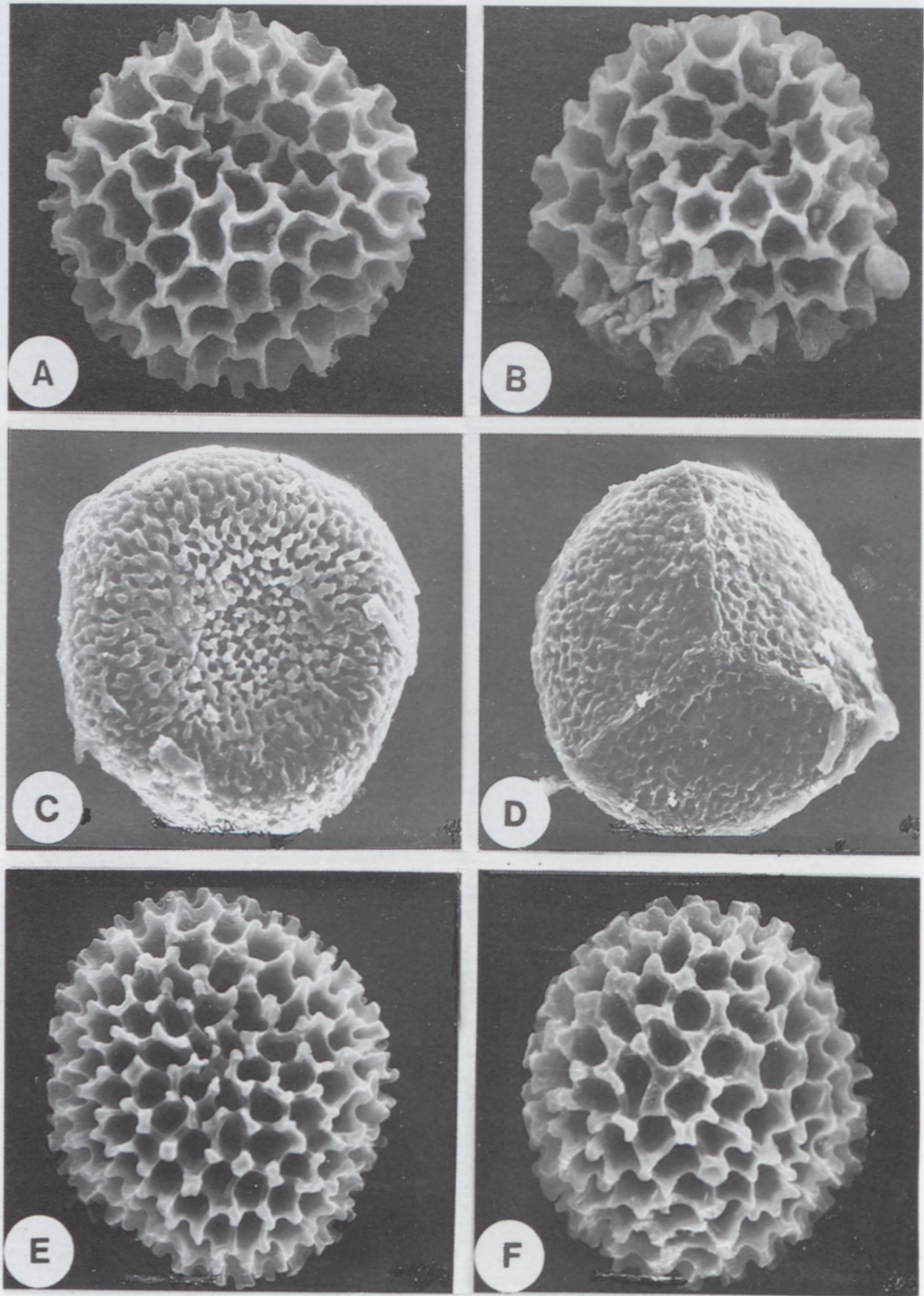


FIGURE 14.—SEM micrographs of spores. A, B, *Riccia symoensii*: A, distal face; B, proximal face. C, D, *R. erubescens*: C, distal face; D, proximal face. E, F, *R. runssorensis*: E, distal face; F, ? proximal face. A, B, *Symoens 7075* (BR); C, D, *Townsend 75/17*; E, *S.M. Perold 2466*; F, *Volk 81/125c*. A, B,  $\times 700$ ; C, D,  $\times 400$ ; E, F,  $\times 600$ .



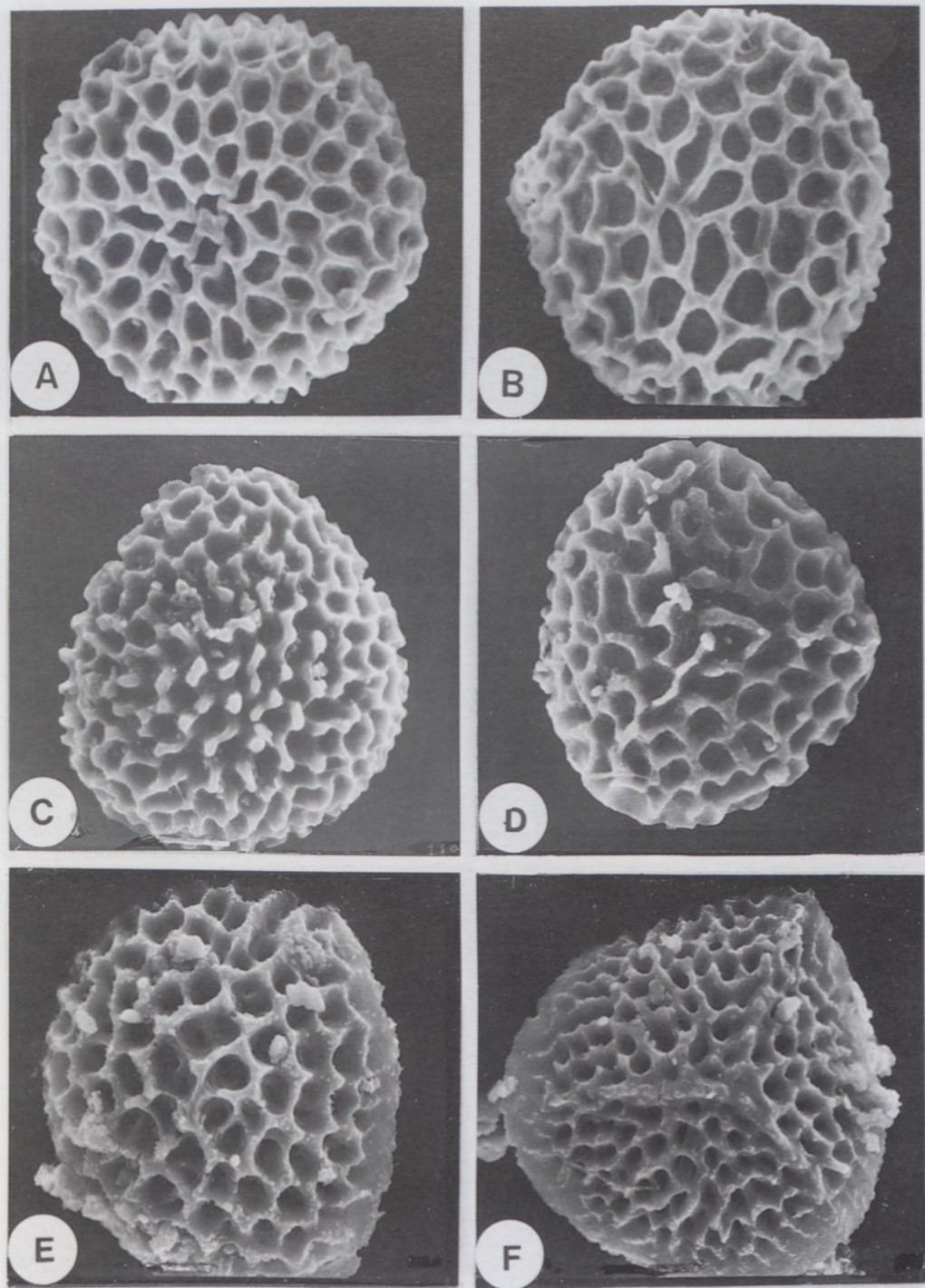


FIGURE 15.—SEM micrographs of spores. A, B, *Riccia rosea*: A, distal face; B, proximal face. C, D, *R. somaliensis*: C, distal face; D, proximal face. E, F, *R. lamellosa*: E, distal face, F, proximal face. A, B, *S.M. Perold 135a*; C, D, *Thulin & Mohamed 7110*; E, F, *Faure s.n.* (E). A, B,  $\times 700$ ; C, D,  $\times 420$ ; E, F,  $\times 550$ .



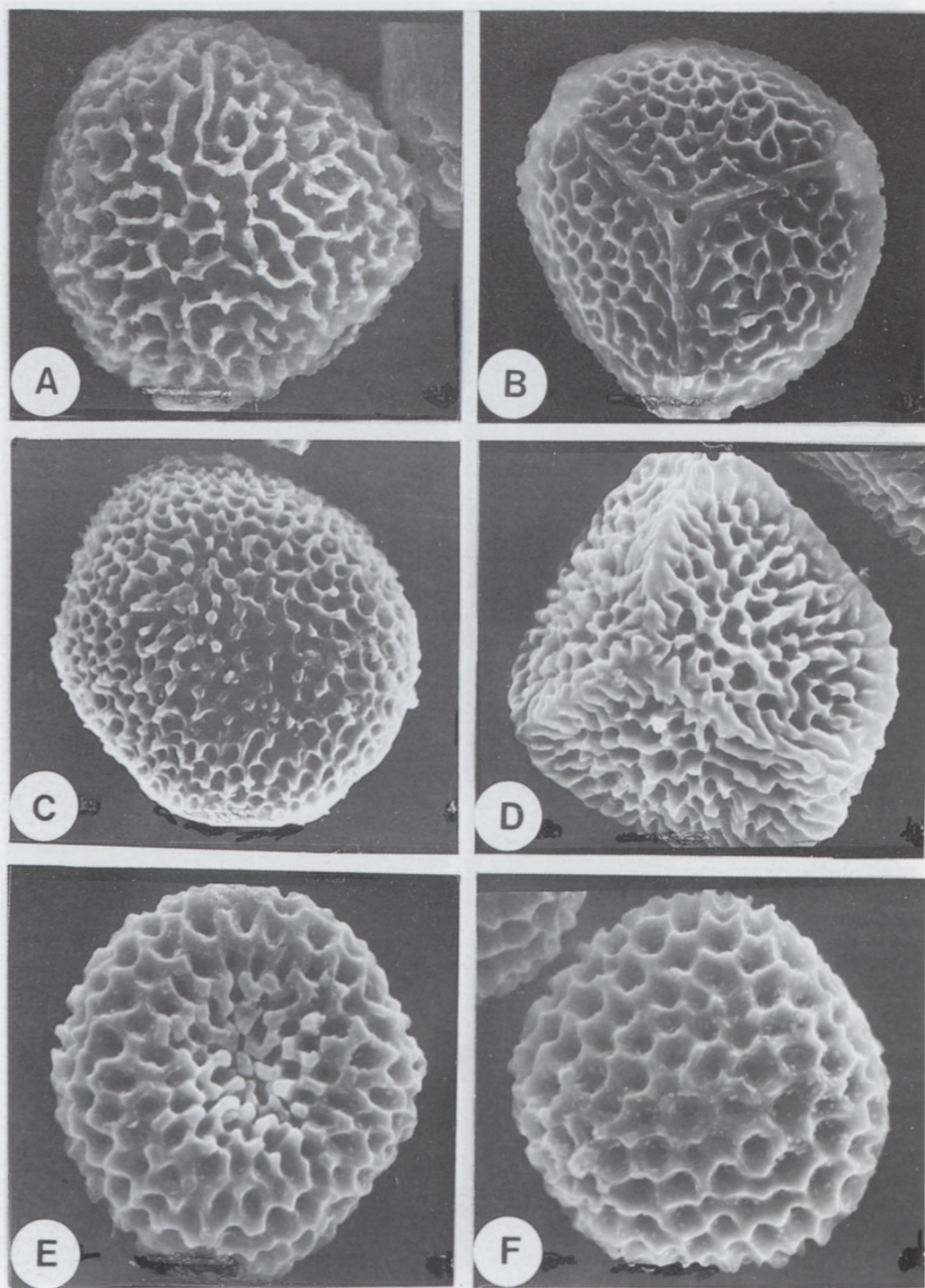


FIGURE 16.—SEM micrographs of spores. A, B, *Riccia albolimbata*: A, distal face; B, proximal face. C, D, *R. albornata*: C, distal face; D, proximal face. E, F, *R. argenteolimbata*: E, distal face; F, proximal face. A, Volk 81/921; B, Stephansen 5393; C, Volk 81/081; D, Smook 6961; E, F, Volk 86/930a. A, B,  $\times 600$ ; C, D,  $\times 700$ ; E, F,  $\times 600$ .



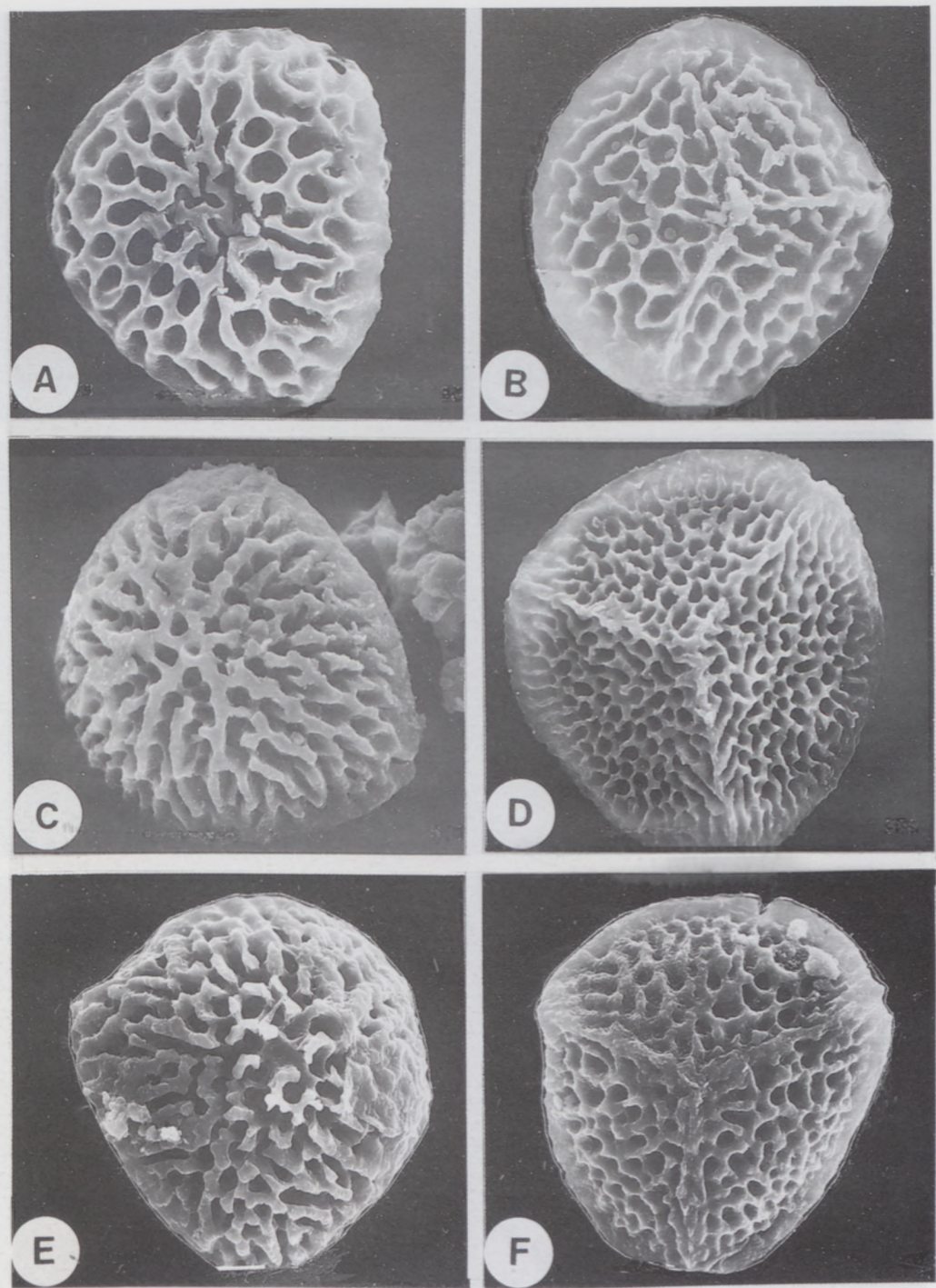


FIGURE 17.—SEM micrographs of spores. A, B, *Riccia montana*: A, distal face; B, proximal face. C, D, *R. alboporosa*: C, distal face; D, proximal face. E, F, *R. bicolorata*: E, distal face; F, proximal face. A, B, *Van Rooy 3549a*; C, D, *Oliver 8849*; E, F, *Smook 6990a*. A, B,  $\times 800$ ; C–F,  $\times 700$ .



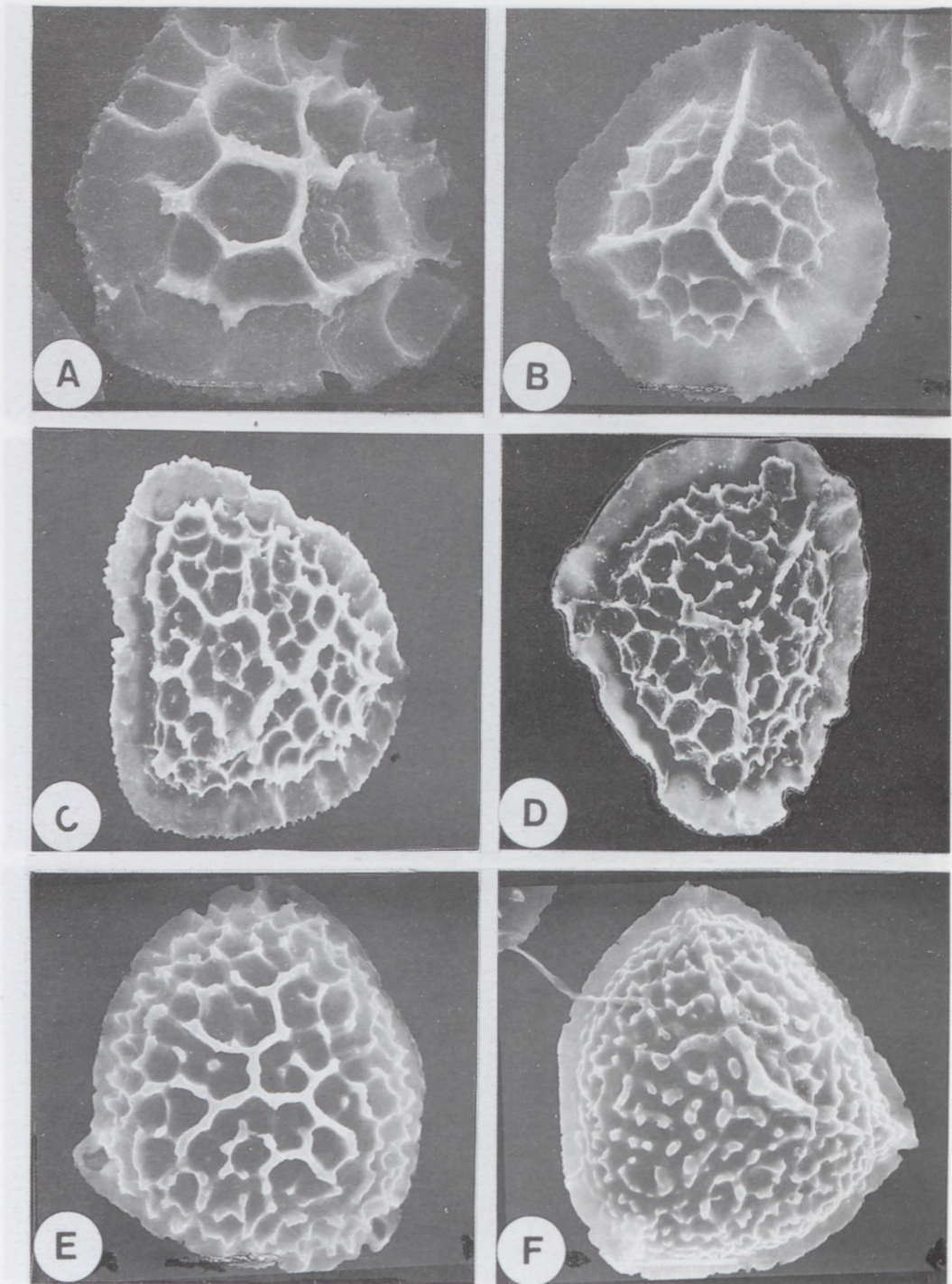


FIGURE 18.—SEM micrographs of spores. A, B, *Riccia hantamensis*: A, distal face; B, proximal face. C, D, *R. alatospora*: C, distal face; D, proximal face. E, F, *R. albovestita*: E, distal face; F, proximal face. A, B, *S.M. Perold 1830*; C, D, *Duthie 5004b*; E, F, *J.M. Perold 44*. A, B,  $\times 800$ ; C, D,  $\times 500$ ; E, F,  $\times 700$ .



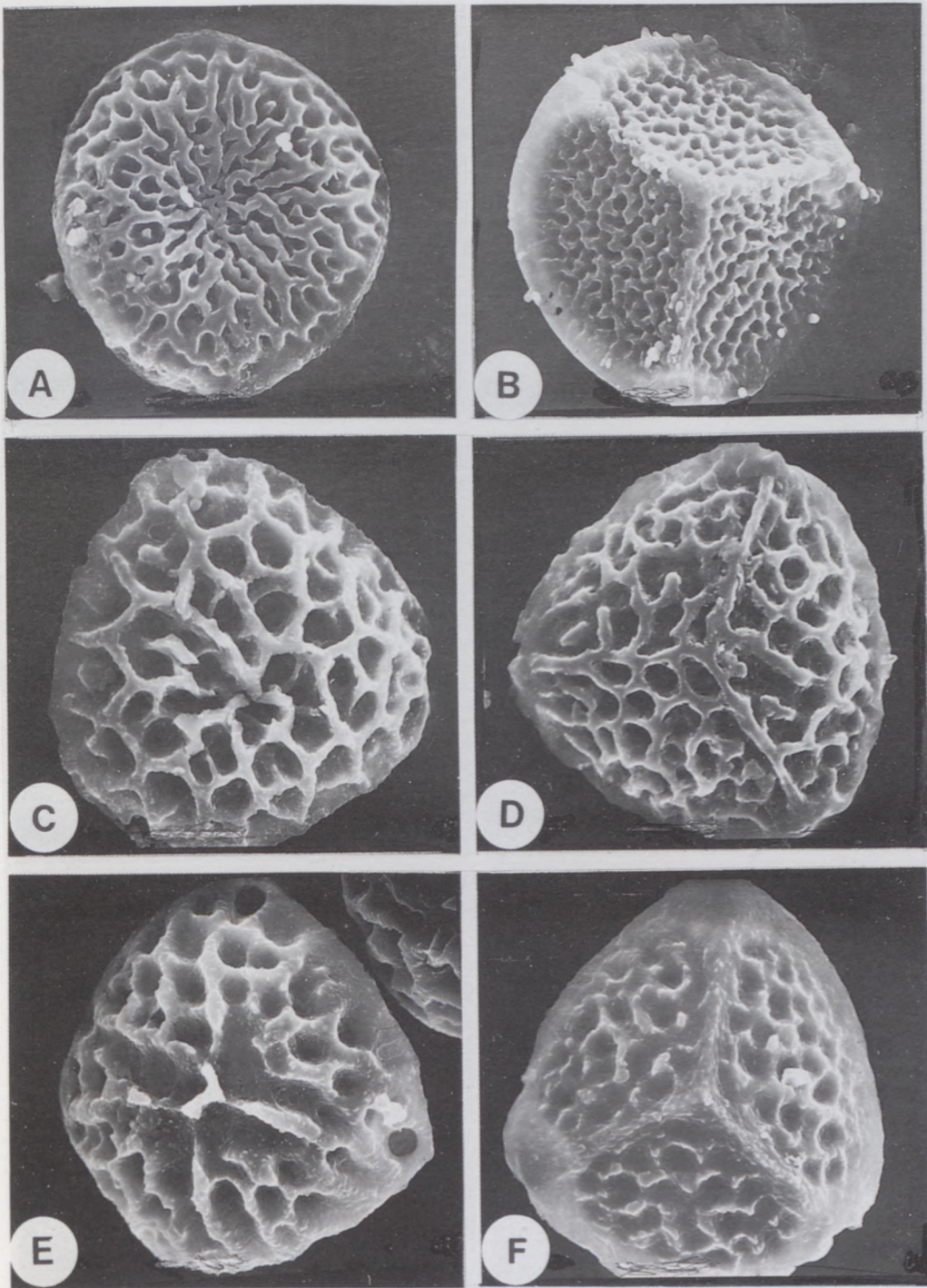


FIGURE 19.—SEM micrographs of spores. A, B, *Riccia concava*: A, distal face; B, proximal face. C, D, *R. elongata*: C, distal face; D, proximal face. E, F, *R. furfuracea*: E, distal face; F, proximal face. A, B, S.W. Arnell 30; C, D, S.M. Perold 2018; E, F, Oliver 8957a. A, B,  $\times 700$ ; C–F,  $\times 600$ .



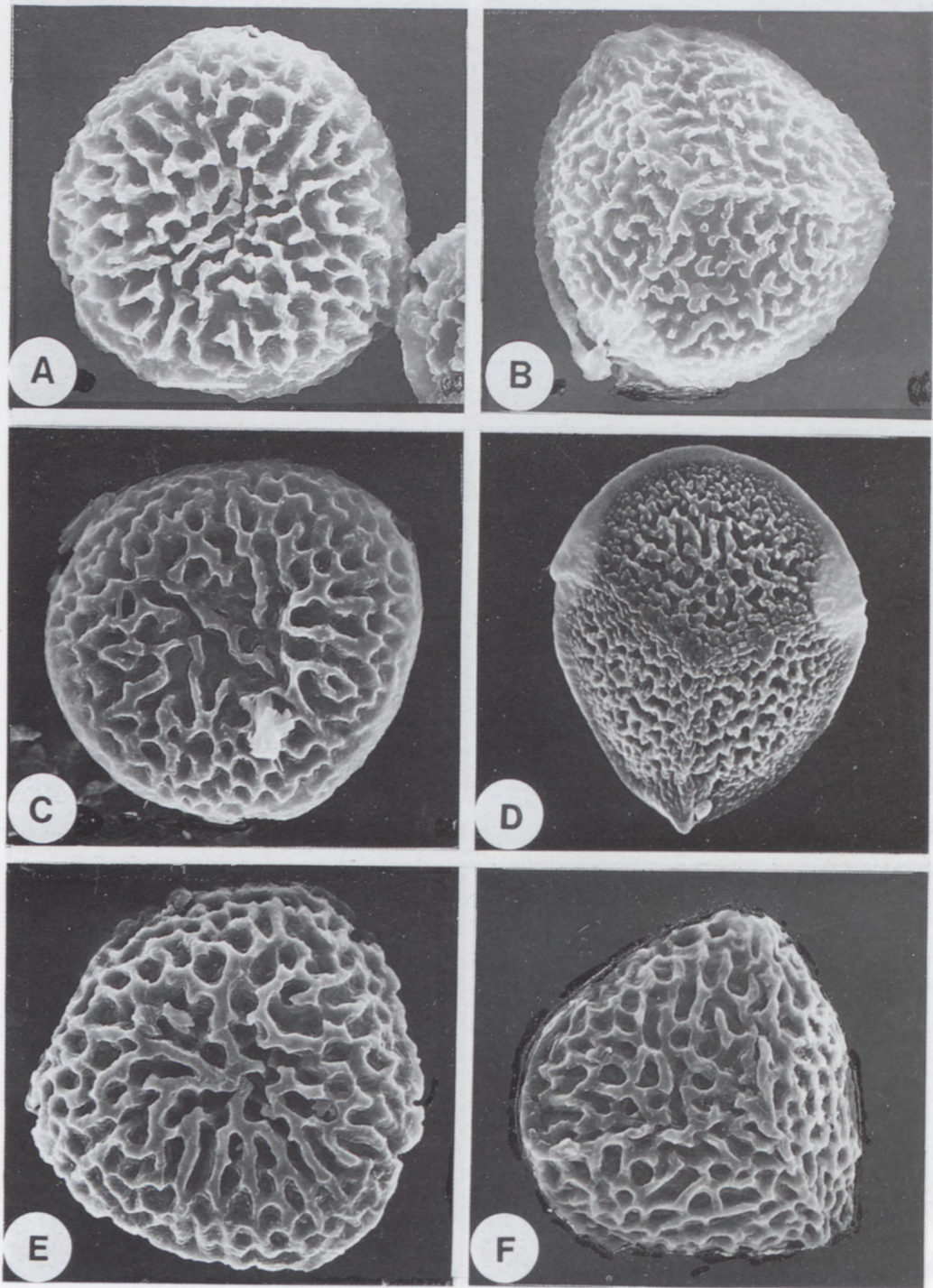


FIGURE 20.—SEM micrographs of spores. A, B, *Riccia trachyglossum*: A, distal face; B, proximal face. C, D, *R. pulveracea*: C, distal face; D, proximal face. E, F, *R. simii*: E, distal face; F, proximal face. A, B, *J.M. Perold* 34; C, *Oliver* 8957a; D, *Duthie* 5484a; E, F, *Smook* 3908. A, B,  $\times 600$ ; C, D,  $\times 700$ ; E, F,  $\times 800$ .



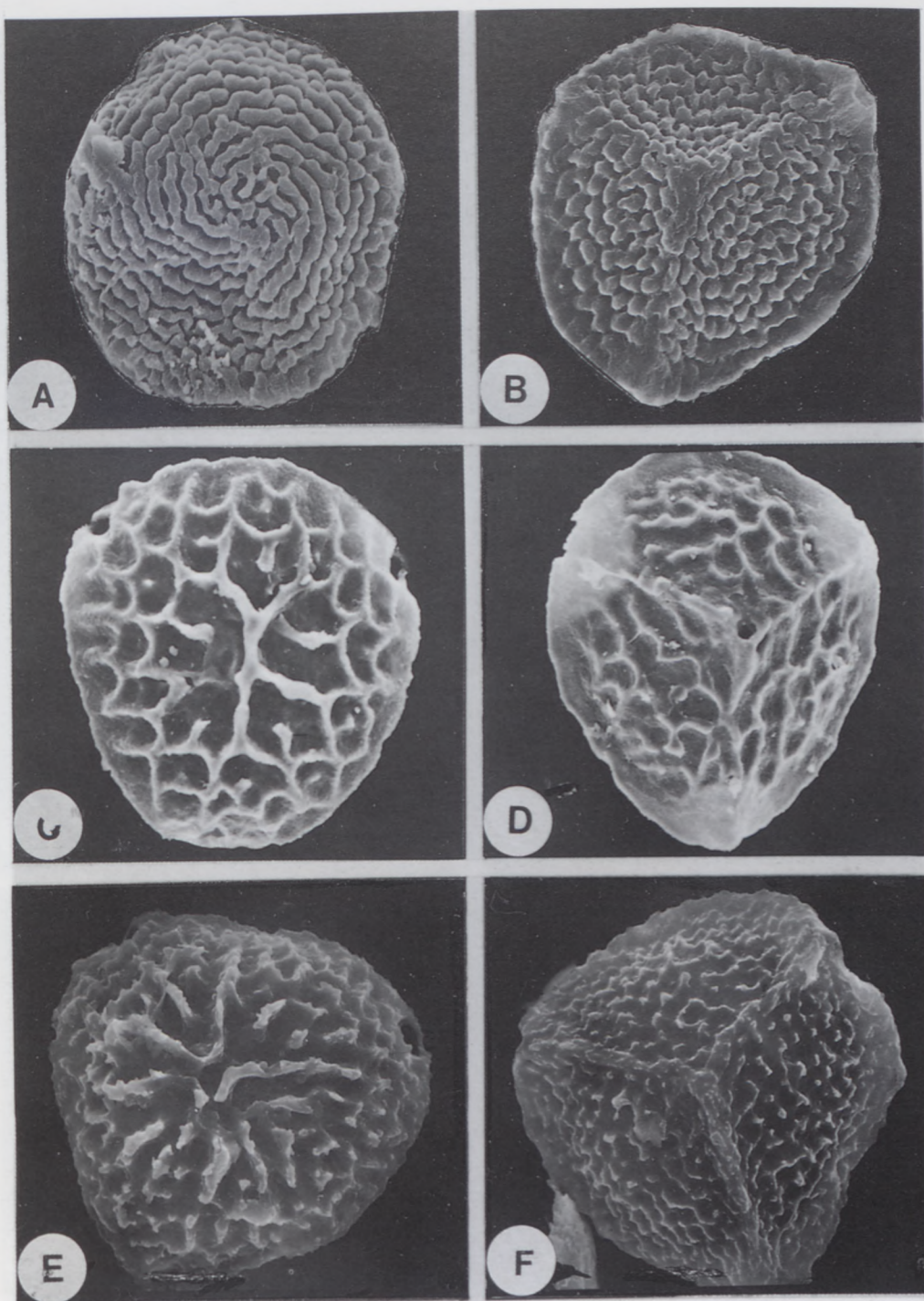


FIGURE 21.—SEM micrographs of spores. A, B, *Riccia villosa*: A, distal face; B, proximal face. C, D, *R. hirsuta*: C, distal face; D, proximal face. E, F, *R. vitrea*: E, distal face; F, proximal face. A, B, *Levyns s.n.*; C, D, *Oliver 8040*; E, F, *S.M. Perold 1425*. A, B,  $\times 800$ ; C–F,  $\times 600$ .



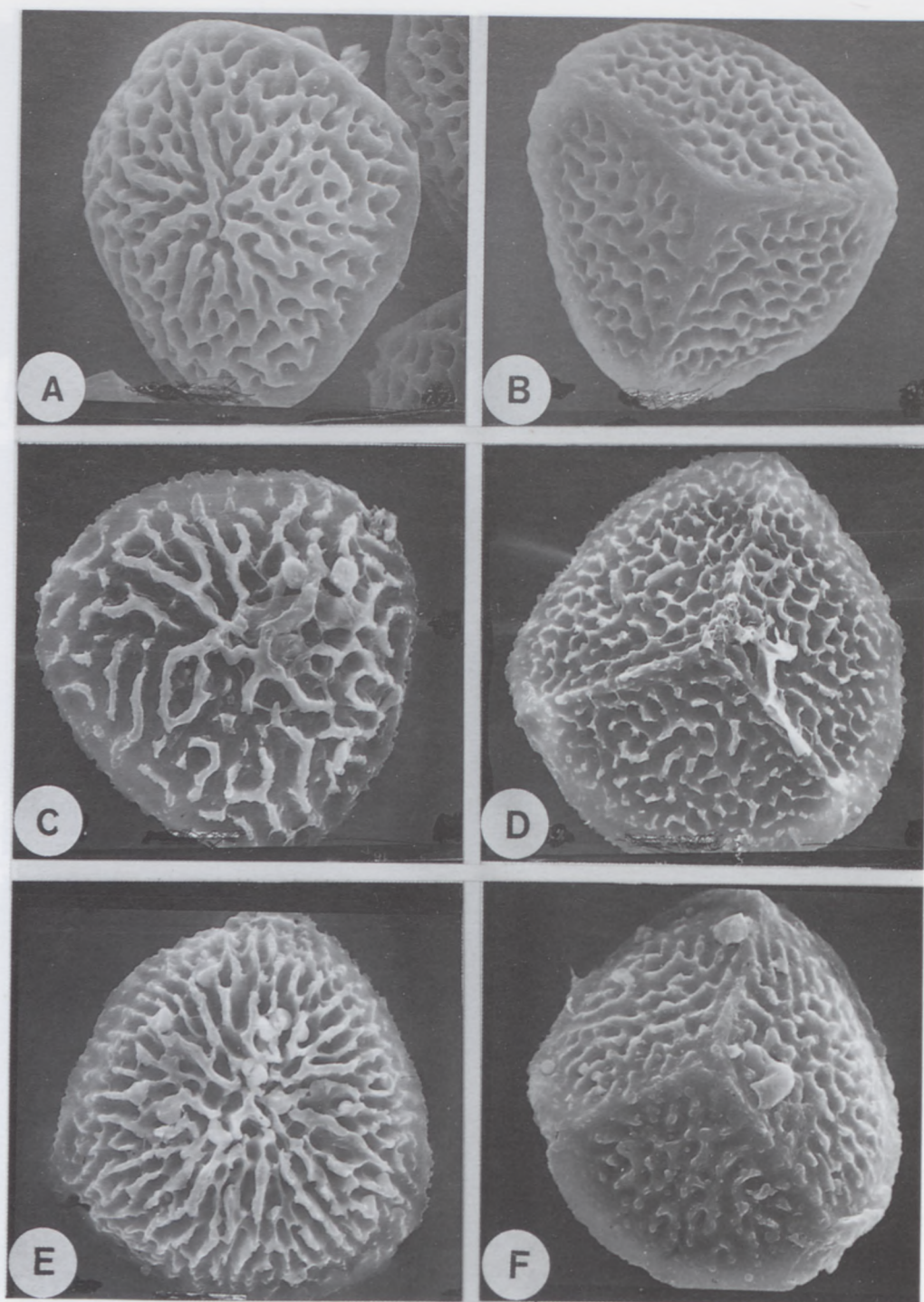


FIGURE 22.—SEM micrographs of spores. A, B, *Riccia albomarginata*: A, distal face; B, proximal face. C, D, *R. namaquensis*: C, distal face; D, proximal face. E, F, *R. ampullacea*: E, distal face; F, proximal face. A, B, *S.M. Perold* 2383; C, D, *S.M. Perold* 1420; E, F, *Van Rooy* 3164a. A, B,  $\times 600$ ; C, D,  $\times 800$ ; E, F,  $\times 700$ .



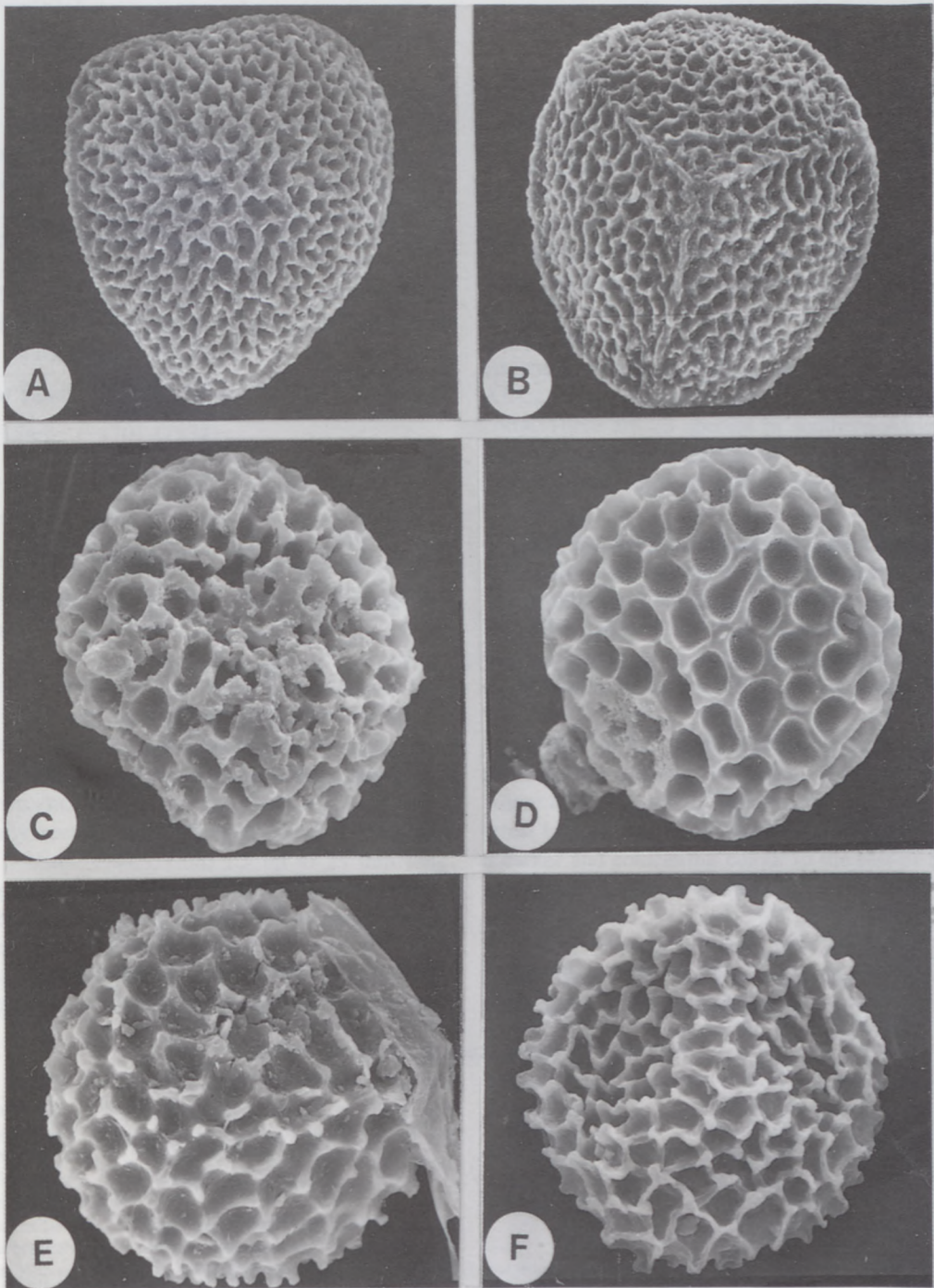


FIGURE 23.—SEM micrographs of spores. A, B, *Riccia parvo-areolata*: A, distal face; B, proximal face. C, D, *R. saharensis*: C, distal face; D, proximal face. E, F, *R. papillispora*: E, distal face; F, proximal face. A, B, *J.M. Perold* 24; C, D, *Chudeau s.n.* (G); E, F, *Beccari 802* (G). A, B,  $\times 700$ ; C, D,  $\times 560$ ; E, F,  $\times 450$ .