

***FOSSOMBRONIA BRACCHIA* CARGILL
(FOSSOMBRONIACEAE, MARCHANTIOPHYTA),
A NEW SPECIES FROM WESTERN AUSTRALIA**

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Abstract: The new species, *Fossombronia brachia*, from Lesueur National Park, an area of high vascular plant endemism and species richness in southwestern Western Australia, is described and illustrated; a distribution map is provided. The new species has strong morphological similarities to the South African species *F. tumida*.

Keywords: *Fossombronia tumida*, Lesueur National Park, liverworts

INTRODUCTION

Fossombronia Raddi (Fossombroniaceae) is highly diverse in Australia, with close to one third of published species currently recorded (Cargill 2021; Söderström *et al.* 2016; Söderström *et al.* 2020; Söderström *et al.* 2022). The genus *Fossombronia* is easily identified by its distinctive “lettuce-like” leaves and typically bright crimson-purple rhizoids (see Figures 1A, B, F and G in Cargill 2021).

Fossombronia is a very common terricolous liverwort in the southwest of the state of Western Australia (WA) (*pers. obs.*), yet very little is known about the species that grow in that state. A draft treatment of the liverworts and hornworts of South Australia, Western Australia and the Northern Territory was commenced by the late David Catcheside as a companion volume to his *Mosses of South Australia* (1980) but it was never published (Andrew Thornhill, in litt.). Catcheside listed only four *Fossombronia* species



for WA in his draft treatment. Scott and Pike (1987) in their second paper on the genus, described one new species endemic to that state (*Fossombronia hewsoniae* G.A.M.Scott & D.C.Pike) and listed WA as a locality for two other species (*F. densa* G.A.M.Scott & D.C.Pike and *F. truncata* G.A.M.Scott & D.C.Pike). Since then, Perold has published many new species for South Africa, none of which are known to occur in Australia (Perold 1999). More recently, Milner *et al.* (2011) published a preliminary phylogeny of Australian species. Many of the accessions used in that study were collected from Western Australia, resulting in additional records for that state (e.g. *F. alata* G.A.M.Scott & D.C.Pike, *F. altilamellosa* G.A.M.Scott & D.C.Pike, *F. pusilla* (L.) Nees and *F. watsii* Steph.). Australasia's Virtual Herbarium (AVH, accessed on 12th January 2023) lists over 700 herbarium collections of *Fossombronia* for the state of WA and of those, a little less than half are identified only to genus (Figure 1). The remainder are identified to species, increasing the state number of species by 13. However, a comprehensive survey of *Fossombronia* species for the whole state is still lacking.

Southwestern Western Australia experienced good winter rains during 2022, resulting in a very good season for *Fossombronia*. Fieldwork in mid 2022 revealed an unusual species from Lesueur National Park, near Jurien Bay, with tumid leaves and spores with a pattern not previously observed. This species is described here as *Fossombronia bracchia* Cargill.

MATERIALS AND METHODS

Live plants from the original field collections and from plants harvested after culturing under glasshouse conditions for three months, were examined and measured for all morphological characters using Leitz compound and dissecting microscopes. All quantitative characters were based on measurements taken from multiple plants (10 plants altogether) to record their range of variation. Where capsules were present, spores were studied with light microscopy (LM). The contents of a single capsule was chosen and partially mounted for LM and also mounted on double sided sticky tape on aluminium stubs, gold-coated with an EmiTech K550X Sputter Coater and viewed using a Zeiss EVO LS 15 Environmental SEM. The Royal Horticultural Society Colour Chart (RHSCC) (Royal Horticultural Society 1995) was used to describe colours of plants.

In situ images of the plants were taken with an Olympus Tough T5 camera or an Apple iPad. Light micrographs from the compound microscope were taken with a Nikon Coolpix 5000 digital camera and from the dissecting microscope with a Leica Flexacam C1 camera. All line drawings were made using drawing tube attachments on both microscopes.

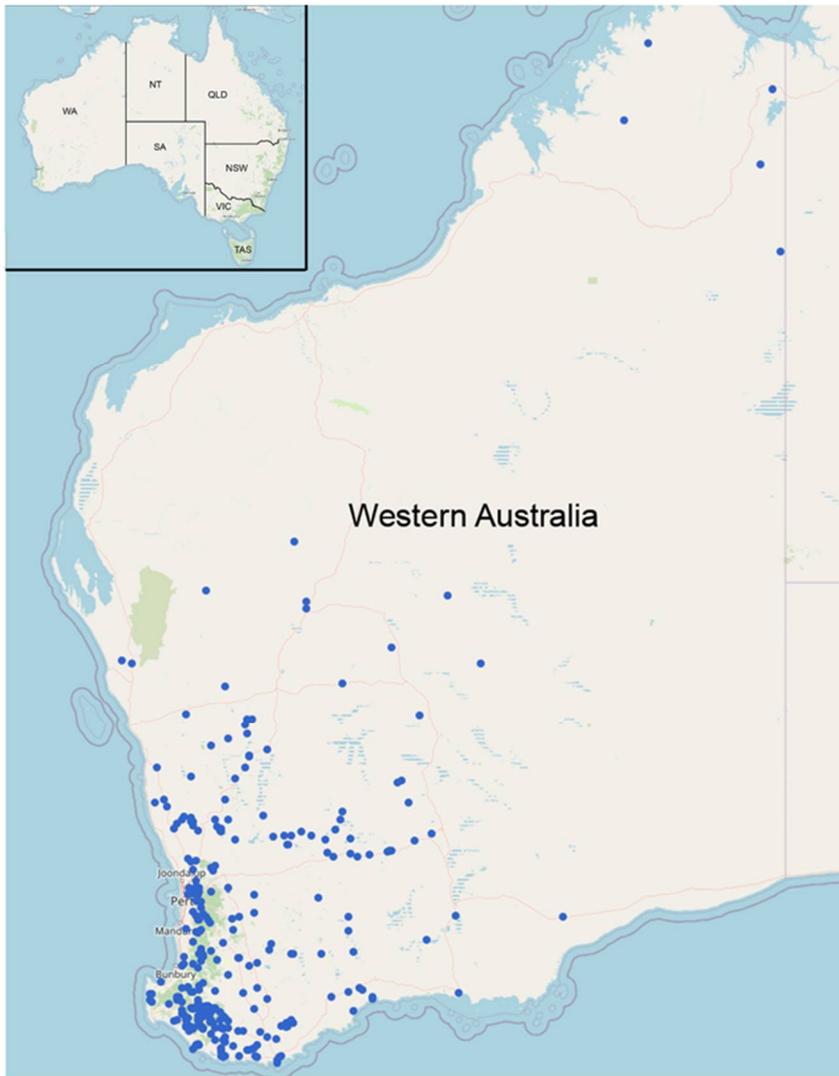


Figure 1. Map of *Fossombronia* collections in the Australasian Virtual Herbarium database (accessed 12th January 2023).

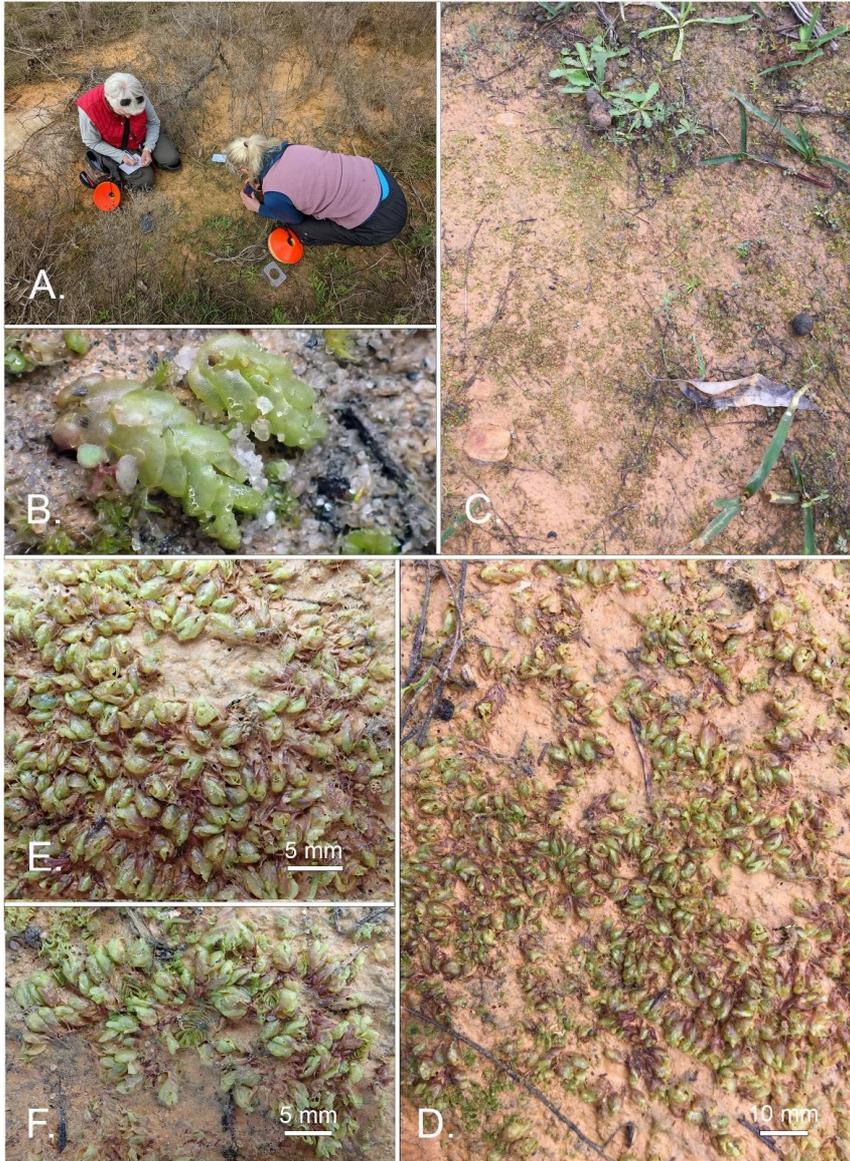


Figure 2. *Fossombronia brachia*. A, C. Habitat. B, D-F. Plants *in situ*. Photo credits: A. Katrina Syme. B. Josephine Milne. C-F. D.C. Cargill.

RESULTS

Taxonomic treatment

Fossombronia brachia Cargill, sp. nov. (Figures 2–8)

Diagnosis. Plants are vegetatively similar to *Fossombronia tumida* Mitten, in having concave, overlapping leaves. Unlike in *F. tumida*, leaves and stems in *F. brachia* are bicoloured. Leaves are reddish-pink and green, while stems are deep crimson-red along the ventral half and pale brown or greenish along the dorsal half. Leaves in *F. brachia* lack the endogenous gemmae that are characteristic of *F. tumida*. The spores of *F. brachia* are larger than those of *F. tumida* (75–112.5 μm vs 47.5–60.8 μm in diameter). Distally, spore patterning is also quite different, *F. brachia* with verrucae or short lamellae in a random pattern vs a reticulate pattern in *F. tumida*, and *F. brachia* has a distinct webbing pattern around the circumference between the protruding spines vs no webbing for *F. tumida*.

Type. Australia: Western Australia. Lesueur National Park, Banovich Rd, 5 Aug. 2022, D.C. Cargill, J. Milne, H. Innes & K. Syme, Coll. No. 1813A (holotype: CANB 954795; isotype: PERTH, MEL). Description based on live plants.

Description. *Plants* in nature gregarious, forming large patches, bright green (RHS 144A & 145A yellow-green group) and with dark crimson towards the base of the plant (RHS 187A greyed-purple group), prostrate, from 5.35 up to 8.7 mm long, 2.2–3.0 mm wide, 1.9–4.0 mm in height; unbranched or sparingly branched, 1x furcate, with branches ventral-lateral. *Leaves* imbricate, clasping, concave, with oblique-longitudinal insertion, succubous, decurrency usually absent, infrequently with antical margin decurrent on some older basal leaves in female plants; variable in shape, from obovate to quadrate broadly lingulate to oblong to ovate, 1.35–3.65 mm long \times 0.94–2.91 mm wide, 0.7–2.7 mm wide at leaf insertion; margins mostly entire, sometimes dentate in female plants, entire to shallowly lobed to bilobed in male plants; very few slime papillae present along margins; leaf apex rounded or truncate; median leaf cells polygonal elongate-rectangular, 52.5–265 μm long \times 27.5–92.5 μm wide, without conspicuous trigones; numerous botryoidal segmented oil bodies in all cells; marginal cells undifferentiated along the apex of leaves, becoming elongated along the sides. *Stems* u or v-shaped in cross section; 530–1500 μm wide \times 440–780 μm high in female plants, 175–1130 μm wide \times 115–630 μm high in male

plants, dorsal tissue pale brown and cells (65–130 × 55–135 µm) larger than ventral tissue cells (22.5–55 × 20–52.5 µm) which are conspicuously reddish maroon. *Ventral scales* not observed. *Rhizoids* thick along ventral surface and flanks of stem, pigmented a deep red wine (RHS 187A greyed-purple group). *Tubers* absent.

Dioicous. Male plants similar to female plants but slightly smaller. Two male plants identified, only a single antheridium able to be measured on dorsal surface posteriorly in between leaves; ovoid, 237.5 × 205 µm. Perigonial scales absent. Archegonia along apical end of stem. Caulocalyces, 1 to 2 per shoot, dorsal, obconical to tubular to campanulate, with or without a single sinus; with the height both greater than and less than the plant width (2.1–3.7 mm high), extending slightly higher than the plant leaves; 1.85–3.15 mm across at the widest point, shortly stipitate; external surface smooth, rufed to undulate; mouth erect to incurved to broadly recurved, with the margin entire to sparsely toothed. Sporophytes emergent, with mature setae 2.2–4.8 mm long. Capsules spheroidal to ovoidal; 0.7–1.05 mm in diameter, dark brown (RHS 200A brown group); epidermal cells hyaline; inner capsule wall cells with orange-brown, annular and nodular thickenings. *Spores* cryptopolar or hemispherical in equatorial view and globose in polar view, 75–112.5 µm diameter, dark reddish brown (unable to match colour to RHS chart), disassociated when mature; distal surface variable, either with numerous verrucae-like protuberances with an irregular apex giving them a “hollowed-out” appearance or with short, irregularly arranged lamellae, often in a zig zag pattern, 20–29 projections around the margin, length of projections 2.5–17.5 µm long, 2.5–12.5 µm wide at base; micro-ornamentation of intervening surface smooth to finely wrinkled and finely papillate, parallel ridges of split lamellae run around the equatorial girdle; proximal surface with a pattern of papillae or fine spidery lamellae; triradiate ridge weak to indistinct; equatorial wing present due to distinct webbing pattern connecting protruding spines around circumference of spore from polar view. *Elaters* abundant, elongate, 57.5–185 µm long, 7.5–22.5 µm wide, branching absent, 2- to multi-spiralled, with spirals moderately to tightly coiled; outer wall hyaline, spirals dark reddish brown, with surface papillate. *Gemmae* lacking.

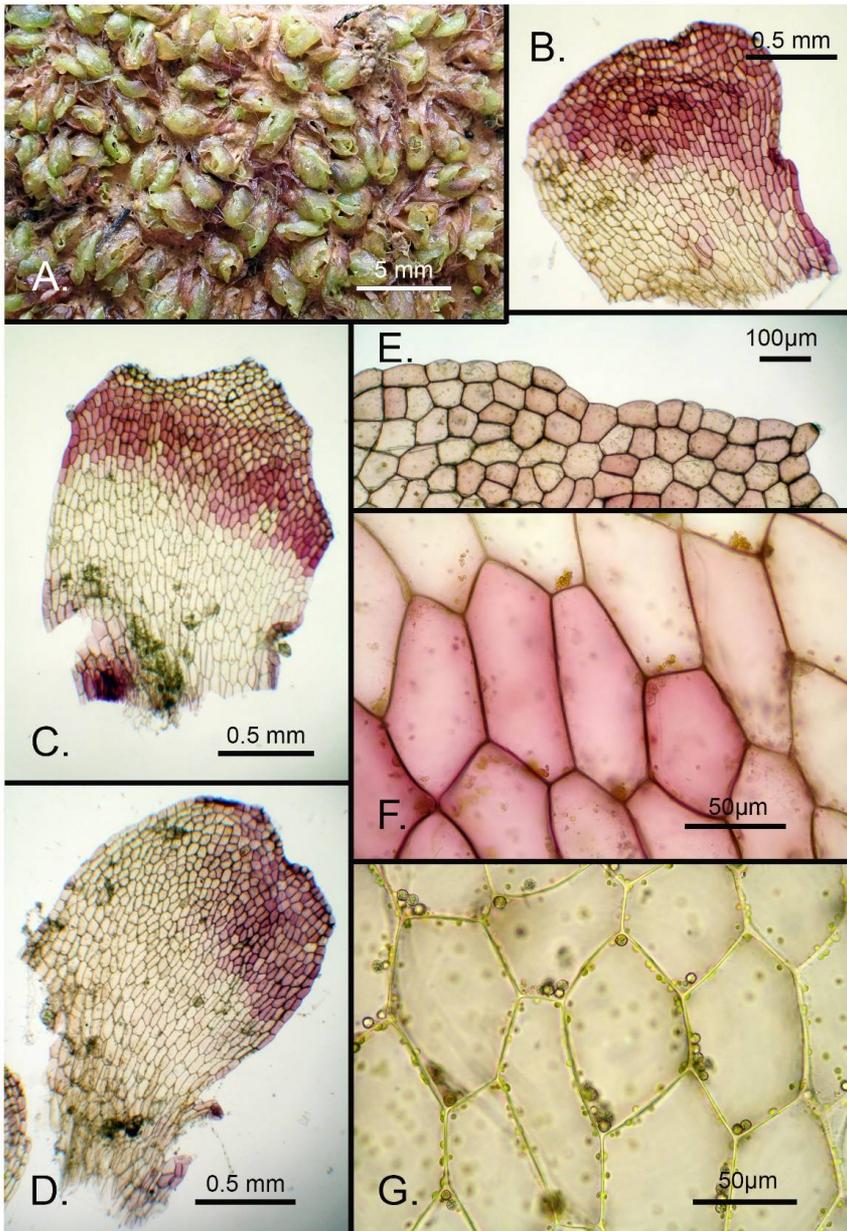


Figure 3. *Fossombronia brachia*. **A.** Plants in their habitat in Lesueur National Park, Western Australia. **B–D.** Vegetative leaves. **E.** Marginal cells of a leaf. **F.** Pigmented lamina cells of a vegetative leaf. **G.** Lamina cells of leaf showing the small, segmented oil bodies typical of the species. All photos taken from the type specimen D.C. Cargill 1813A. Photo Credits: A-G. D.C. Cargill.

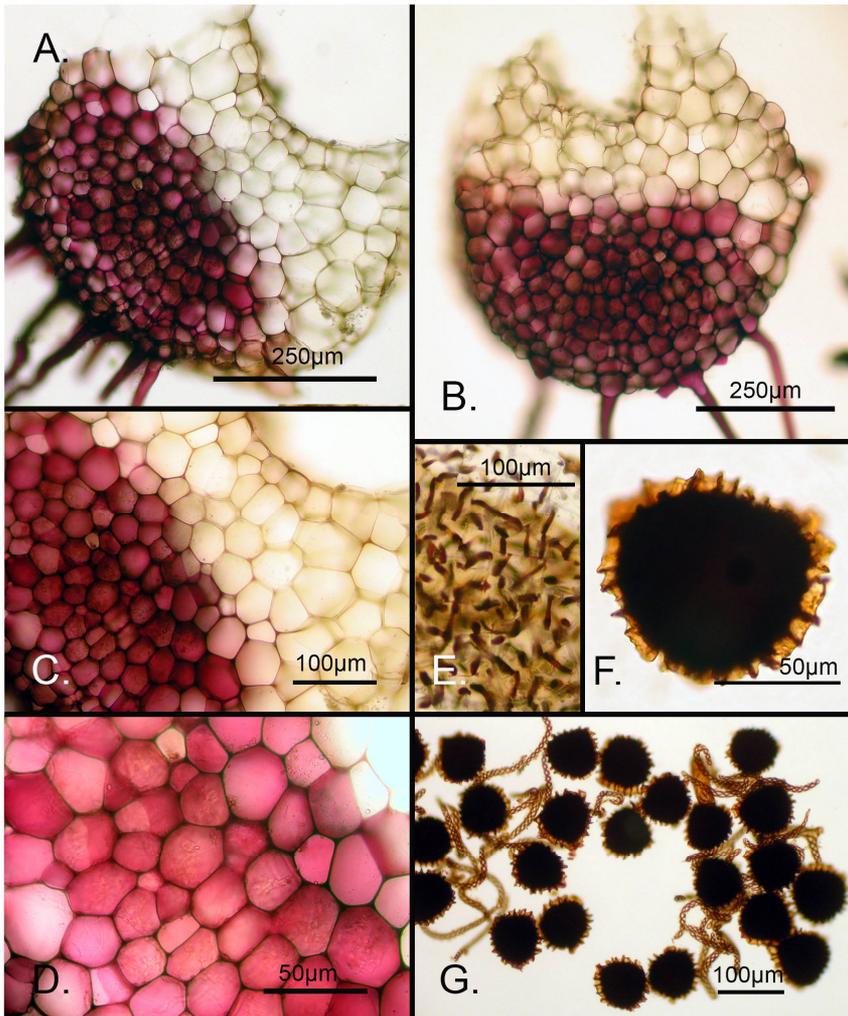


Figure 4. *Fossombronia brachia*. **A-D.** Cross sections of stems showing the distinctly bicoloured dorsal and ventral tissues and the larger dorsal cells of the stem compared to the dark red pigmented ventral cells. **E.** Two layered capsule walls, an outer hyaline layer and an inner pigmented layer with wall thickenings. **F.** Single spore showing webbing of the equatorial wing. **G.** Spores and elaters. Photos A-D taken from the type specimen *D.C. Cargill 1813A*. Photos E-G taken from *D.C. Cargill 1813B*. Photo credits: D.C. Cargill.

Etymology. From the Latin *bracchium* meaning ‘claw of a crab’. Named for the morphological similarity of the gametophyte branches to the claws of a crab.

Distribution and habitat. Known only from the type locality (Figure 8), on bare patches of compacted silty mud over sand. Lesueur National Park lies in the Geraldton Sandplains IBRA bioregion (see <https://www.dcceew.gov.au/environment/land/nrs/science/ibra>) which is characterised by scrubby, heath-like vegetation community known as kwongan (see Beard 1976). The population was found in a drainage line flowing west to east, so is likely being fed by nutrient poor soils of Lesueur NP and not the adjacent farmland to the east, borne out by the numerous carnivorous plant species growing nearby (Innes, pers. obs.).

Conservation status. This species has not been formally evaluated and is so far only known to occur at one locality in Lesueur National Park. According to IUCN criteria (IUCN 2019), *F. brachia* would be listed as “Not Evaluated”. It should be noted that the hydrology of the surrounding area has been heavily altered by agriculture and the population of *F. brachia* is growing only 100 metres away from cleared farmland. This may have a negative impact on the bryophyte communities, including that in which *F. brachia* occurs, in the longer term.

Specimens examined. Australian Capital Territory. CULTIVATED. Australian National Botanic Gardens. Research glasshouse. Aug. 2022 to 2 Nov. 2022 (grown on from live wild material collected from Lesueur National Park, Western Australia). *D.C. Cargill 1813B*. (CANB 958671).

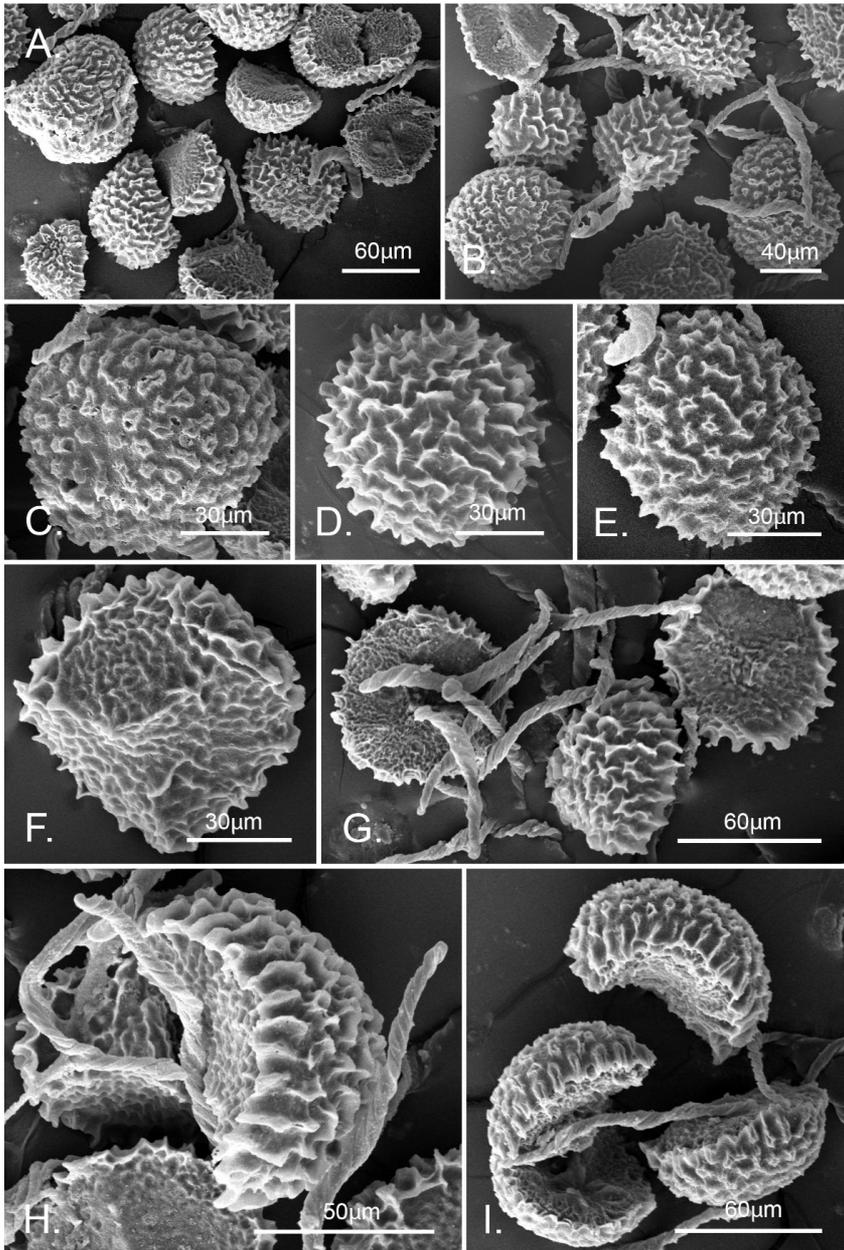


Figure 5. *Fossombronia bracchia*. SEM images of spores. **A–B.** group of spores displaying the variability of the patterning of the distal face. **C, D** and **E.** Distal faces of 3 different pattern types found within a single capsule. **F.** Proximal face of spore. **G.** Proximal faces and side view of spores and elaters. **H–I.** Side views of spores showing the distinct ridging pattern along the equatorial girdle. All photos taken from *D.C. Cargill 1813B*. Photo credits: D.C. Cargill.

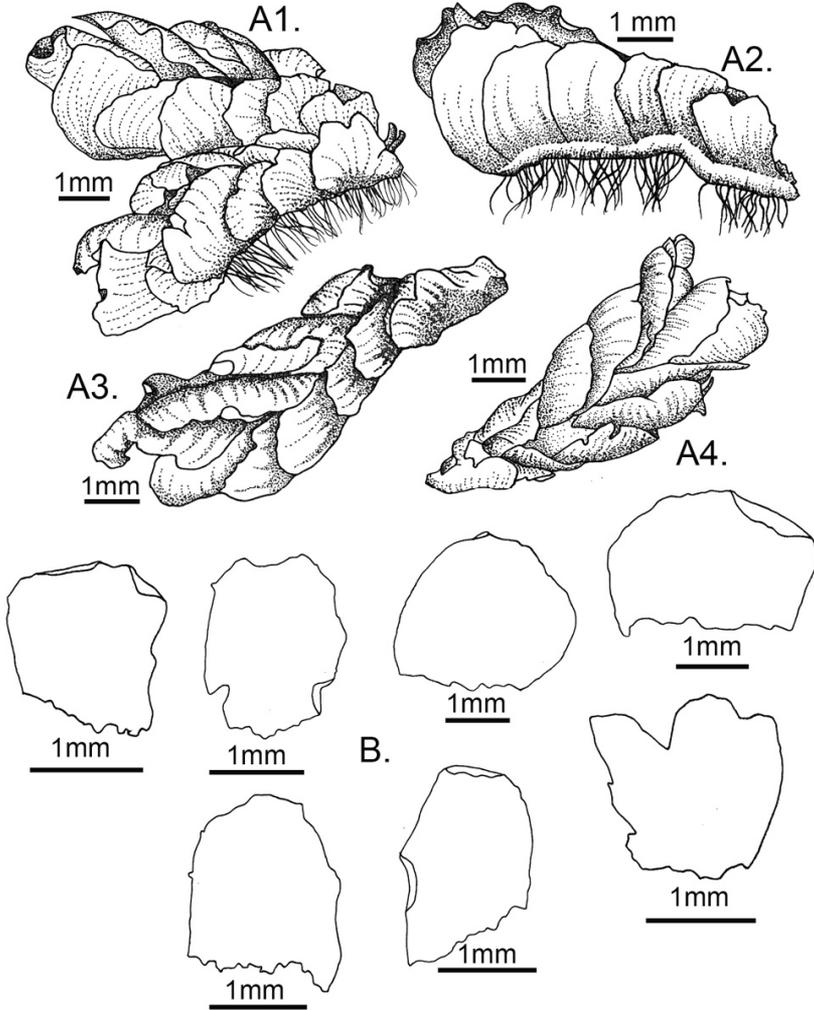


Figure 6. *Fossombronia brachia*. **A1, A3** and **A4**. Dorsal views of male plants. **A2**. Side view of **A4**. plant below in dorsal view. **B**. Vegetative leaves of male plants. All drawings made from the type specimen *D.C. Cargill 1813A*. Illustration credits: D.C. Cargill.

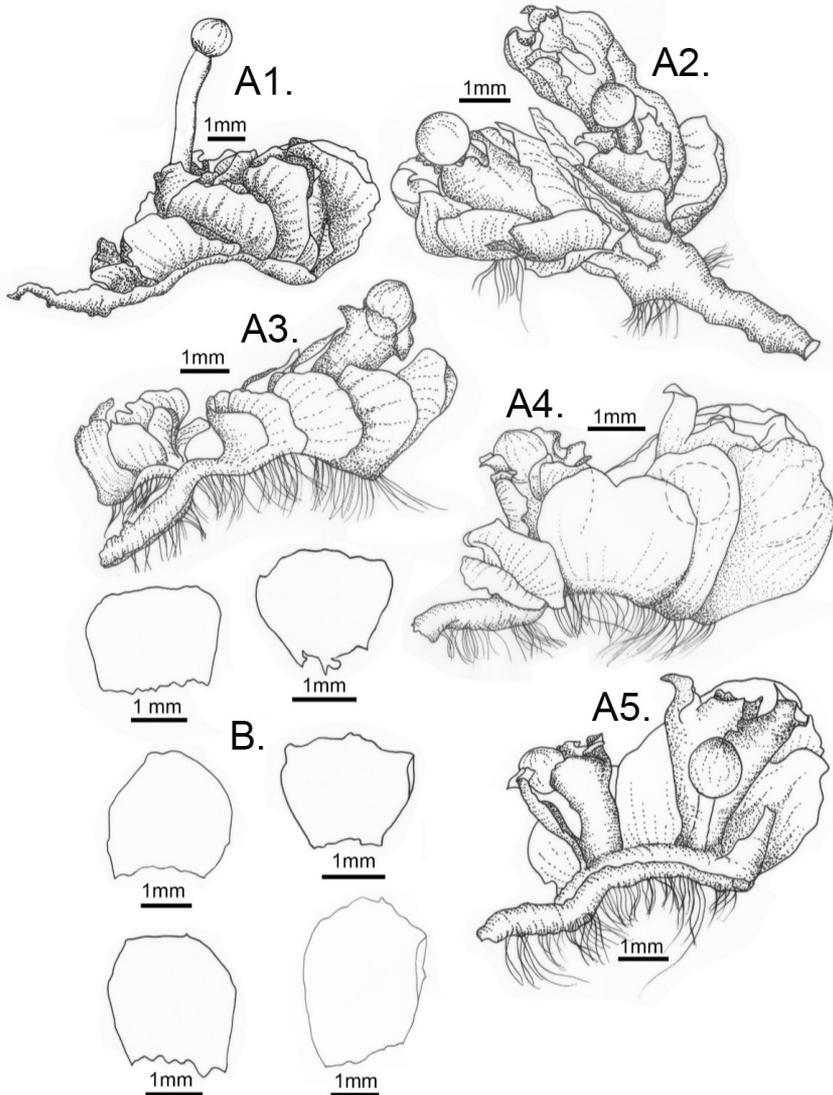


Figure 7. *Fossombronia brachia*. **A1–A5.** Fertile female plants. **A5.** Side view of A4, female plant above, with the leaves removed to reveal the two caulocalyces of the same plant below. **B.** Vegetative leaves of female plants. All drawings made from the specimen *D.C. Cargill 1813B*. Illustration credits: D.C. Cargill.

DISCUSSION

Fossombronia bracchia most closely resembles the South African species, *Fossombronia tumida* (Perold 1997). It is also superficially similar to the Australian *F. intestinalis* Taylor and *F. pseudo-intestinalis* Cargill (Cargill 2021). All four species have concave, tumid, overlapping leaves, however, the leaves of *F. bracchia* are not multilobed (characteristic of *F. intestinalis* and *F. pseudo-intestinalis*), but instead are mostly an unlobed or shallowly bilobed, oblate or ovate or lingulate leaf shapes. Leaves in *F. bracchia* are tumid and concave, each leaf overlapping the leaf in front. The leaves have a succubous insertion along the stem. This habit is very similar to *F. tumida* (Cargill 2001) (Figures 9A–C), which also has concave, overlapping leaves. Differences between the two species include the endogenous gemmae, frequently found in the leaves of *F. tumida* (Figures 9C, D). These were described by Perold (1997) as “single cells often stained red and containing a dark, round, internally granular body, rarely 2, up to 50 pm in diameter ...” but instead are a type of gemma (Cargill 2000). These gemmae have not been observed in *F. bracchia*. The leaves of both *F. intestinalis* and *F. pseudointestinalis* are also closely imbricate, whereby it can be difficult to see where one leaf end and the other begins. This is not the case in *F. bracchia* or *F. tumida* (Figures 2B, 9B and C) where the leaves are imbricate, but individual leaves are clearly differentiated.

While *F. intestinalis* and *F. pseudointestinalis* are monoicous, *Fossombronia bracchia* and *F. tumida* are dioicous. There less difference between the two sexes in *F. bracchia*, compared to *F. tumida* in which male plants are longer, narrower and more lax than female plants. Other differences can also be seen in spore size and ornamentation. Spores in *F. bracchia* are much larger, possibly the largest spores described in the genus to date (see Cargill 2000), 75–112.5 µm in diameter. They are 47.5–60.8 µm in diameter in *F. tumida*, 32–45 µm in *F. pseudointestinalis* and those of *F. intestinalis* are 40–47.5 µm. The spores of both *F. tumida* (Figure 9E) and *F. intestinalis* (see Figure 7D in Cargill 2021) have a reticulate distal pattern vs an irregular pattern of verrucae and short lamellae sometimes forming a zig zag pattern in *F. bracchia*. *F. pseudointestinalis*. has vermiculae on the distal face, not observed in *F. bracchia*.

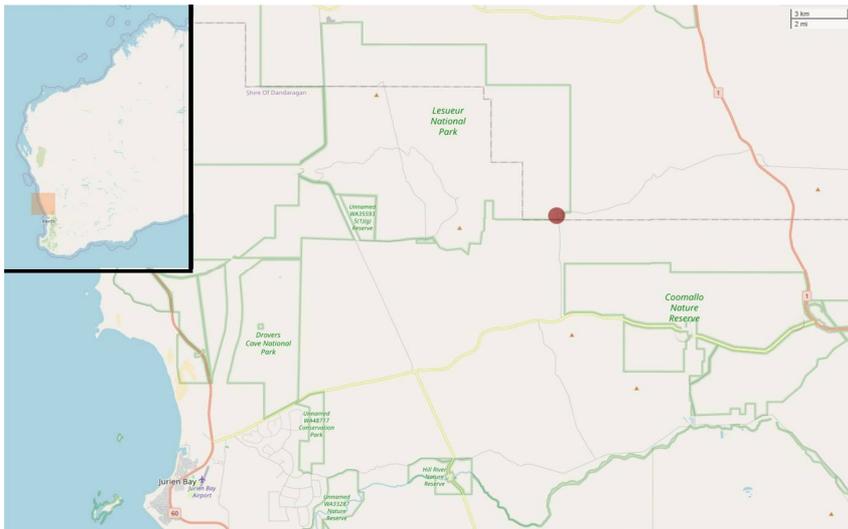


Figure 8. Map of the type locality of *F. bracchia* (indicated by a red dot) in Lesueur National Park. Inset shows the state of Western Australia and the location of the main map.

Lesueur National Park has been identified as a region of high vascular plant endemism and species richness (Hopper and Gioia 2004). It was recently placed on the National Heritage list in 2016 (<https://www.legislation.gov.au/Details/C2016G00600>) due to its unique native flora. AVH (accessed 11 January 2023) lists only six collections of *Fossombronia* from the Geraldton Sandplains (IBRA 7 region). It is likely that the rich vascular plant diversity of this area will be mirrored in the bryophyte flora, in particular the liverwort and hornwort floras, which have to date been poorly explored.

This paper is dedicated to Professor Tamás Pócs on the special occasion of his 90th birthday. May he continue his great work on the hepatics for many more years to come.

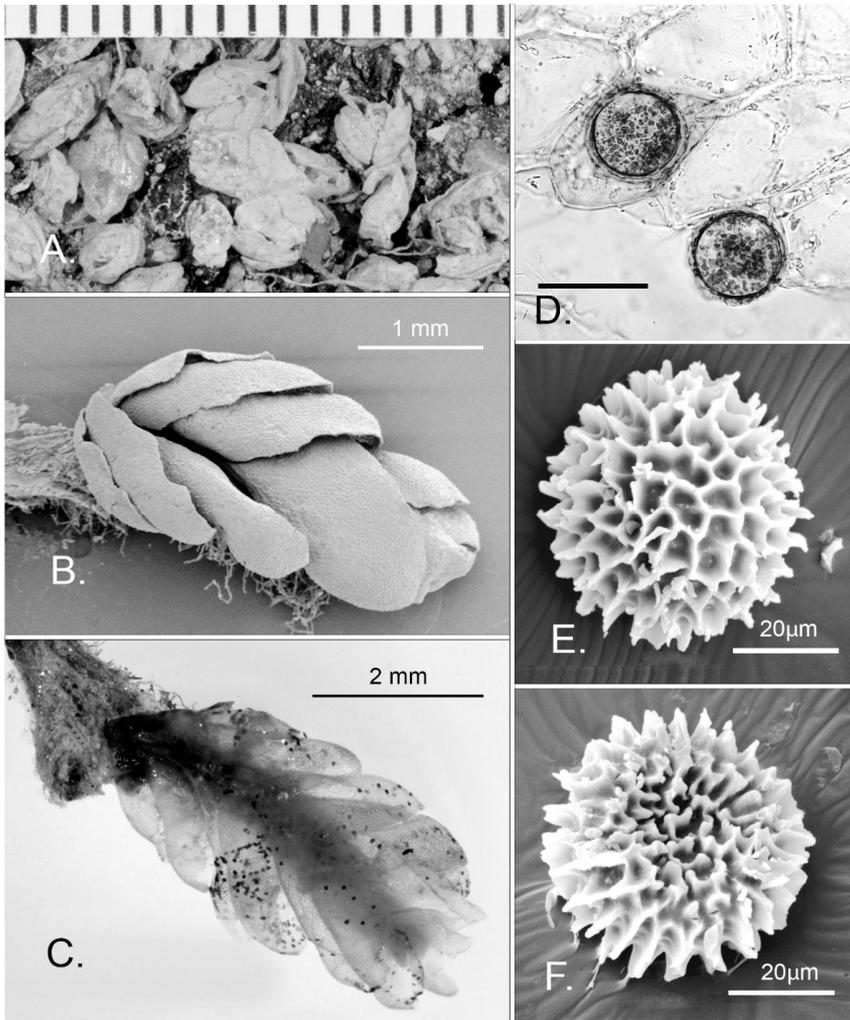


Figure 9. *Fossombronia tumida*. **A.** Dried herbarium specimen of female plants of *F. tumida*. **B.** SEM image of a female plant showing the overlapping clasp leaves. **C.** LM view of a female plant showing the endogenous gemmae seen as spots in the leaves. **D.** A magnified view of the endogenous gemmae in the leaf cells. **E.** Distal view of spore. **F.** Proximal view of spore. A. *S. Garside 6109* (BOL), B-C. *A. Rehmann 63* (NY), D. *H.A. Wager 39* (PRE), E-F. *A.V. Duthie 1 & 2* (PRE-CH1580). All images taken by D.C. Cargill from PhD dissertation 2000 [2001].

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