BOTANIC GARDENS OF SYDNEY

Telopea

Journal of Plant Systematics

ISSN 2200-4025 (Online)

Riccardia gynandra (Aneuraceae, Marchantiophyta) a new species from Rakiura, New Zealand, similar to *R. crassa*

David Glenny[1]

New Zealand Institute of Bioeconomy Science, P.O.Box 69-040, Lincoln 7640, New Zealand.

Email: glennyd@landcareresearch.co.nz

Abstract

Riccardia gynandra Glenny is described from a lowland site on Stewart Island. It resembles *R. crassa* (Schwaegr.) C.Massal. in size and branching but has a smooth epidermis and is monoicous. It has unusual features in the genus: gametangia are ventro-lateral on the thallus margins and male and female branches are sometimes sympodial (together on the same branch). Male branches are variable in their orientation, between inclined slightly downwards to oriented downward at 90° to the ventral thallus surface.

Introduction

The genus *Riccardia* S.F.Gray was revised by Hewson (1970) for Australia, Hässel de Menendez (1972) for southern South America, and Brown and Braggins (1989) for New Zealand. Of 31 species recognised in New Zealand by Brown and Braggins (1989), 20 species are endemic (63%). Of the 11 non-endemic species, 10 are shared with Australia and three are more widespread. *Riccardia crassa* (Schwaegr.) C.Massal. is widespread in Asia, Australasia, South America. *Riccardia alcicornis* (Hook.f. & Taylor) Trev. is shared by South America, Australia, and New Zealand. *Riccardia alba* (Colenso) E.A.Br. is present in Fiji, Australia, and New Zealand. Since the revision of Brown and Braggins (1989), Four additional *Riccardia* species have been added to the New Zealand flora by Glenny (2024, 2025a, 2025b, 2025c).

Riccardia gynandra Glenny was collected in 2019 from a remote location on Stewart Island, 50 km south of Oban during a sea-kayaking trip and identified by me then as *R. filicina* (Colenso) E.A.Hodgs. The specimen was re-examined in 2025 as part of a review of specimens of *R. filicina* and *R. crassa* for the Liverwort Flora of New Zealand project. A search of CHR specimens of *R. filicina* and *R. crassa* found no other specimens of *R. gynandra*. The species is so similar to *R. crassa* that it could easily be overlooked as distinct from that species without examining the epidermis for the presence of striate verrucose outer wall thickenings.

Methods

Dried shoots were soaked briefly in warm water then soaked in pure domestic bleach for a few minutes until the thallus was clear, rinsed in water and then stained with 0.2% methylene blue for a few seconds and rinsed again in water (the "bleach and blue" method of Rico (2011) cited in Reeb and Bardat (2014) to show surface features such as the surface texturing, hyaline papillae, and rhizoids. Reeb and Bardat (2014) note that "bleach has the property of reinflating the old collapsed thalli, and the methylene blue rigidifies them, making possible nice cross sections." Ruthenium red stain was also used, after dissolving crystals of the stain in pure water. Light microscope photography was done with a Leica DM2500 using differential phase contrast.

Glenny D (2026) *Riccardia gynandra* (Aneuraceae, Marchantiophyta) a new species from Rakiura, New Zealand, similar to *R. crassa*. *Telopea* 30: 137–143. doi:10.7751/telopea21860

Received: 18 December 2025
Accepted: 26 March 2026
Published: 17 April 2026

Terminology follows Brown and Braggins (1989) for naming of parts such as stolons and mucilage papillae. Following Glenny (2025b), the surface of the male branch that has antheridial pits is referred to as the clathrate surface as the male branch can face dorsally or ventrally in *Riccardia*, as in this species where the clathrate surface varies in its orientation.

Taxonomy

Riccardia gynandra Glenny, *sp. nov.*

Type: New Zealand: Rakiura / Stewart Island, Tūtaekawetoweto / Lords River, gully behind Lords River Hut, 168.132343°E, 47.105632°S, 15 m, forest of *Metrosideros umbellata* and *Pterophylla racemosa* with *Dicksonia squarrosa* and *Carpodetus serratus* understorey, on rotting wood and *Dicksonia* tree fern debris, with *Lobatiriccardia alterniloba, Pohlia* sp., 18 February 2019, *D. Glenny 14446* (holotype: CHR 657841; isotype: F).

Diagnosis: Monoicous. Primary shoots sympodial and richly branching. Gametangial branches ventro-lateral, often of mixed sexuality when in pairs or triplets. Male branches with 2–10 antheridia per branch. Male branches variable in orientation from slightly tilted ventrally to oriented vertically downwards. Male branch lacking a raised or unistratose marginal wing. Thallus epidermal surfaces smooth. Endomycorrhizas present in the dorsal and ventral epidermis. Branch apices slightly emarginate. Mucilage papillae often persistent.

Description: Primary shoots 10–23 mm long, 10–11 mm wide including branches, prostrate, richly branched and layering in the upper half of primary shoots so that from above they form a dense overlapping mass in which only the upper half of each shoot is visible (Fig. 2A). Primary shoots sympodial, branching abundant with several axes of the same size as the main axis, and rebranching dichotomously and repeatedly (Fig. 1). Stolons abundant in lower half of primary shoot, 250 µm wide, lateral or ventro-lateral in origin, simple or branched, geotropically positive (Fig. 1, 2C). Rhizoids sparse on the older parts of the thallus and stolons, sometimes in clusters on adjacent cells, 100–200 µm long, 18–20 µm diameter, simple or slightly branched at the apex. Thallus 1150–1300 µm wide, 310–480 µm and 9–12 cells deep, width to depth ratio 2.7–3.7, biconvex (Fig. 3A). Apex truncate, very slightly emarginate (Fig. 2D), the meristematic tip 20–50 µm below the highest point of the lobes, on narrow branches occasionally notched and up to 180 µm deep. The central, terminal lobe 0.85–1.25 mm wide, adjacent lateral lobes 0.5–0.7 mm wide. Deep sinuses between branches without slime papillae and not the site of meristem cell division, very narrow initially, the cells at the base of the sinus strongly sinuous. Mucilage papillae straight, clavate, 53–77 µm long, 20–32 µm in diameter, consistently present at the emarginate apex, not projecting beyond the meristematic edge, becoming larger and scattered on the ventral surface (not in rows), persisting sparsely the whole length of the primary shoot (Fig. 2B and D). Marginal wing absent (Fig. 3C). Marginal cells as for epidermal cells (rectangular), near the meristematic points becoming isodiametric, then taller than wide (20–25 × 15 µm). Walls of marginal cells not thicker than the rest of the epidermal cells. Epidermal surfaces completely smooth. Oil-bodies unknown. Dorsal epidermal cells smaller than internal cells with an abrupt transition (Fig. 4A),in surface view rectangular, 180–24 µm long, 45–60 µm wide, length to width ratio 1.8–2.8. Cell walls 2 µm thick, sinuous, with concave thickenings at the cell wall junctions and slight intermediate thickenings (Fig. 4C). Subepidermal cells 130–150 µm long, 50–85 µm wide, length to width ratio 1.6–3.0 (Fig 4D). Ventral epidermal cells smaller than internal cells with an abrupt transition, in surface view rectangular, 35–70 µm long, 18–30 µm wide, length to width ratio 1.3–2.2. Walls thin, with slight concave thickenings at the cell wall junctions, intermediate thickenings absent but sometimes slightly sinuous (Fig. 4C). Subepidermal cells 140–210 µm long, 50–58 µm wide, length to width ratio 2.8–3.6. Thallus in transverse section with dorsal epidermal cells 28–37 µm deep, ventral epidermal cells 34–39 µm deep, internal cells 32–59 µm deep, 1.2–1.5× as deep as dorsal epidermal cells (Fig. 3A). Endomycorrhizae present in dorsal and ventral epidermal layers as segmented hyphae (Fig. 3B and D).

Monoicous. Male and female branches abundant and intimately mixed, not in different parts of the primary shoot (Fig. 1), separate from one another and adjacent (Fig. 2C), or sympodial in single sex or mixed sex clusters of 2 or 3. Not truly synoicous (Fig. 5A). Sexual branches ventro-lateral on thallus margins and often at the base of a sinus formed by two branches (Fig. 5C), almost hidden from dorsal view by the thallus. Male branches 400–770 µm long, 270–410 µm wide, simple or branched from a common base, longer than wide, with an apical sinus 45–140 µm deep with slime papillae on the ventral side of the sinus base, rhizoids absent. Branches angled downwards or pointing vertically downwards from the plane of the parent thallus (Fig. 5C). Branch margins not winged or raised, the apical, marginal, and clathrate surface cells mamillose and c. 50 µm in diameter. Antheridial pits separated by 2–3 rows of cells (Fig. 5B). Antheridia 2–10 per branch, in two rows, 120–130 µm in diameter. Female branches 200–230 µm long, 200–270 µm wide, wider than long, ventrally bulbous at the branch base, without rhizoids, 3-lobed at the apex with slime papillae in the sinuses between the lobes, apical and lobe margin cells larger, 50 µm in diameter, mamillose. Immature calyptra smooth at the apex. Mature calyptra 2.4–2.7 mm long, 0.6 mm in diameter uncompressed, 6 cell layers thick, with pachydermal cells densely scattered, without a differentiated umbo or boss (Fig. 5D). Figures 1–5.

Distribution and ecology: Endemic to New Zealand and currently known only from the type locality, Tūtaekawetoweto / Lords River, on the eastern coast of Rakiura / Stewart Island. The location is 1.5 km from the coastal headlands at a point where the river is tidal and broadens to almost 1 km, and the site is about 20 m distant and 15 m above the river. *Metrosideros umbellata – Pterophylla racemosa* forest is the most widespread and common forest type on Rakiura as *Nothofagus* is absent from the island. The substrate was rotting wood and *Dicksonia* tree fern debris. The gully in which the species was found was not unusual and suggests that it may be more widely distributed in the south-west of the South Island and elsewhere on Rakiura.

Recognition: *Riccardia gynandra* looks very like *R. crassa* in the field but there is no other New Zealand species it could be mistaken for. In common with *R. crassa,* primary shoots are short, densely branched (compare Fig. 1 with Fig. 6A–D). In both species the primary shoots are loosely prostrate and strongly overlapping, the upper parts of each primary shoot layered over other primary shoots to produce a dense pure mat (compare

Fig. 2A with Fig. 6E). In both species, primary shoots are brown in older parts that are not visible in the mats (compare Fig. 1 with Fig. 6B). Stolons are abundant in both species (compare Fig. 1 with Fig. 6D). Gemmae are absent from both. Terminal branches are wide and truncate at their apices (compare Fig. 2B–D with Fig. 6E).

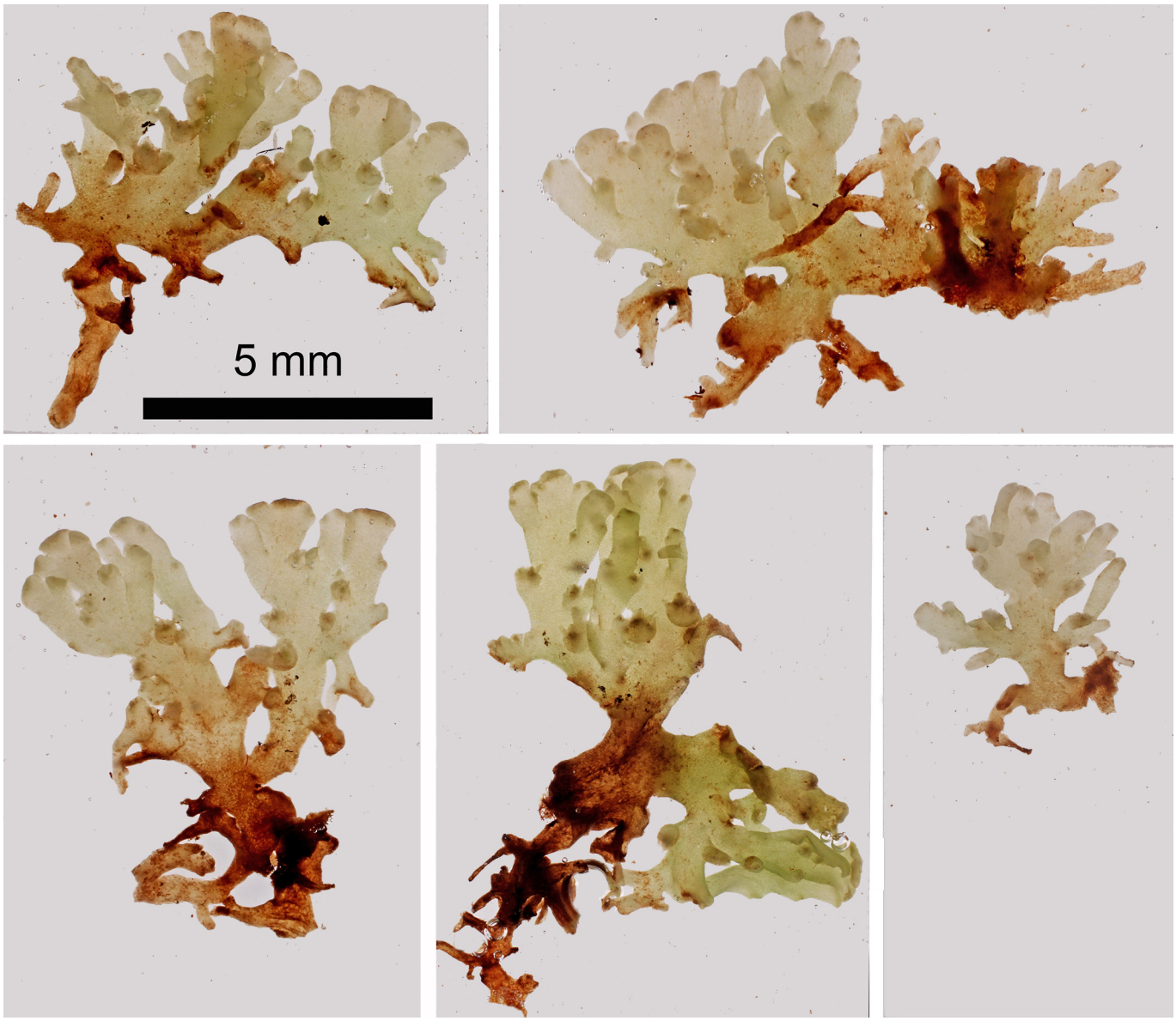

Figure 1. *Riccardia gynandra*, whole shoot systems in ventral view showing the sympodial, highly branched form of the primary shoot, brown pigments in older parts, abundant stolons and abundant sexual branches. All from the type (*D. Glenny 14446*, CHR 657841).

Riccardia gynandra differs from *R. crassa* in the following respects. Primary shoots are shorter, only 10–23 mm long. Thallus surfaces are smooth, not striate. The mucilage papillae are smooth, not striate as in *R. crassa*. Endomycorrhizae are present in the dorsal and ventral epidermis of *R. gynandra* versus absent from *R. crassa*. The thallus apex is very slightly emarginate, not deeply notched as in *R. crassa*. *Riccardia gynandra* is monoicous while *R. crassa* is dioicous (but see note under Table 1). Gametangia are ventro-lateral on branch margins whereas in *R. crassa* they are strictly lateral. Male branches are small and simple with only 2–5 antheridia per branch; those of *R. crassa* are much larger and often branched. The male branches lack a raised or unistratose marginal wing.

Riccardia gynandra is also similar to *R. tenerrima* (Steph.) A.Evans of Tierra del Fuego, Juan Fernandez, and Tristan da Cunha (Hässel de Menendez, 1972). The two species are similar in branching structure, thallus width and in being monoicous. However, there are ample differences, as follows. *Riccardia tenerrima* has a thinner thallus. Endomycorrhizae are absent from *R. tenerrima*. Gemmae are present in *R. tenerrima* but unknown in *R. gynandra*. Stolons are present in both but in a very unusual position in *R. tenerrima*, at the apices of sexual branches, whereas in *R. gynandra* they are in the normal position, lateral or ventro-lateral from thallus margins. Gametangia are strictly lateral in *R. tenerrima* but ventro-lateral in *R. gynandra*. Antheridia are fewer per male branch in *R. gynandra*.

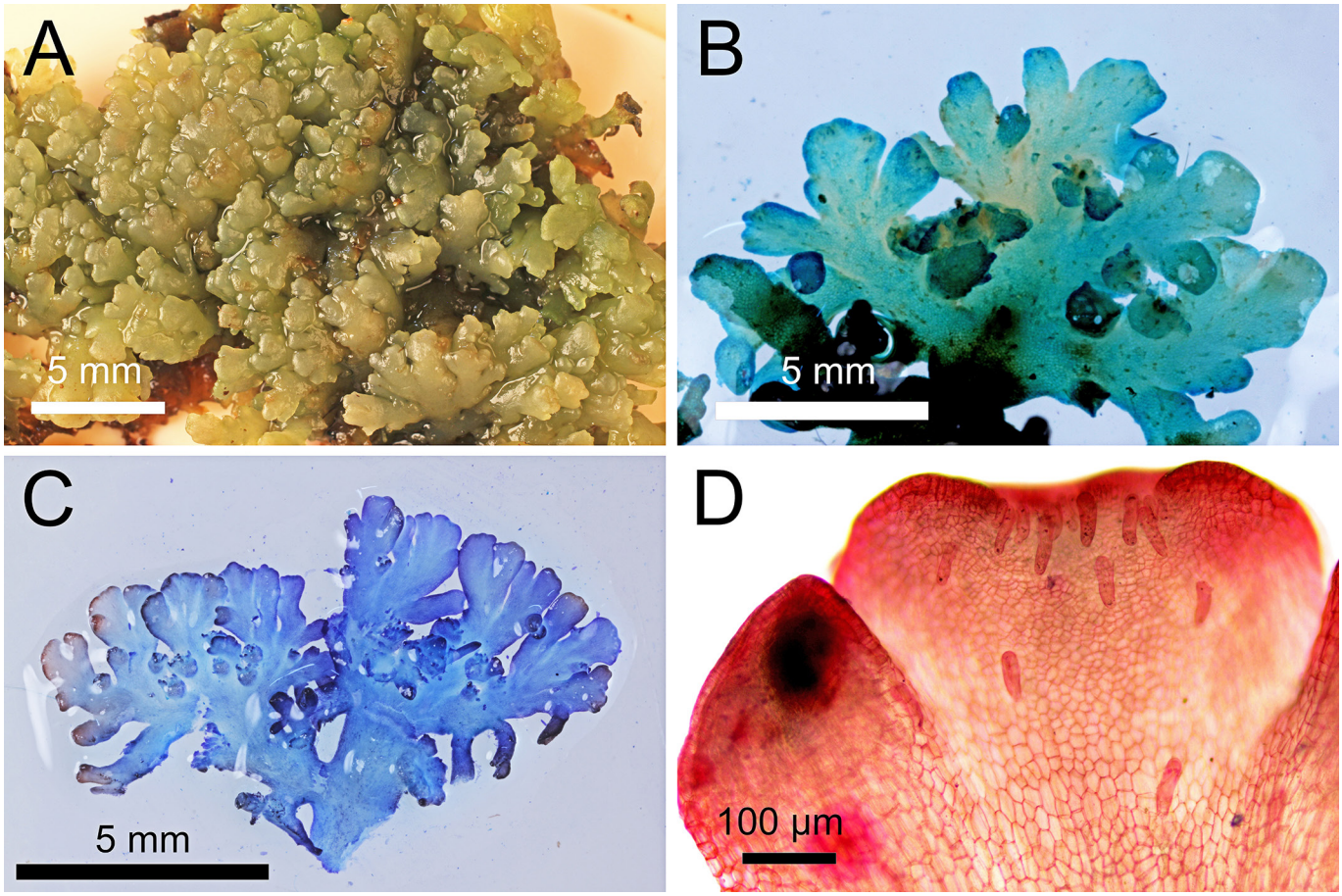

Figure 2. *Riccardia gynandra*. A. Rehydrated partial type specimen showing overlap of shoots to form dense mat. B. Ventral view of shoot system showing persistent mucilage papillae. C. Ventral view of shoot system showing male and female branches and stolons. D. Ventral view of apex of a major branch showing broadly truncate, shallowly emarginate apex and mucilage papillae. B and C bleached and stained with methylene blue. D bleached and stained with ruthenium red. All from the type (*D. Glenny 14446*, CHR 657841).

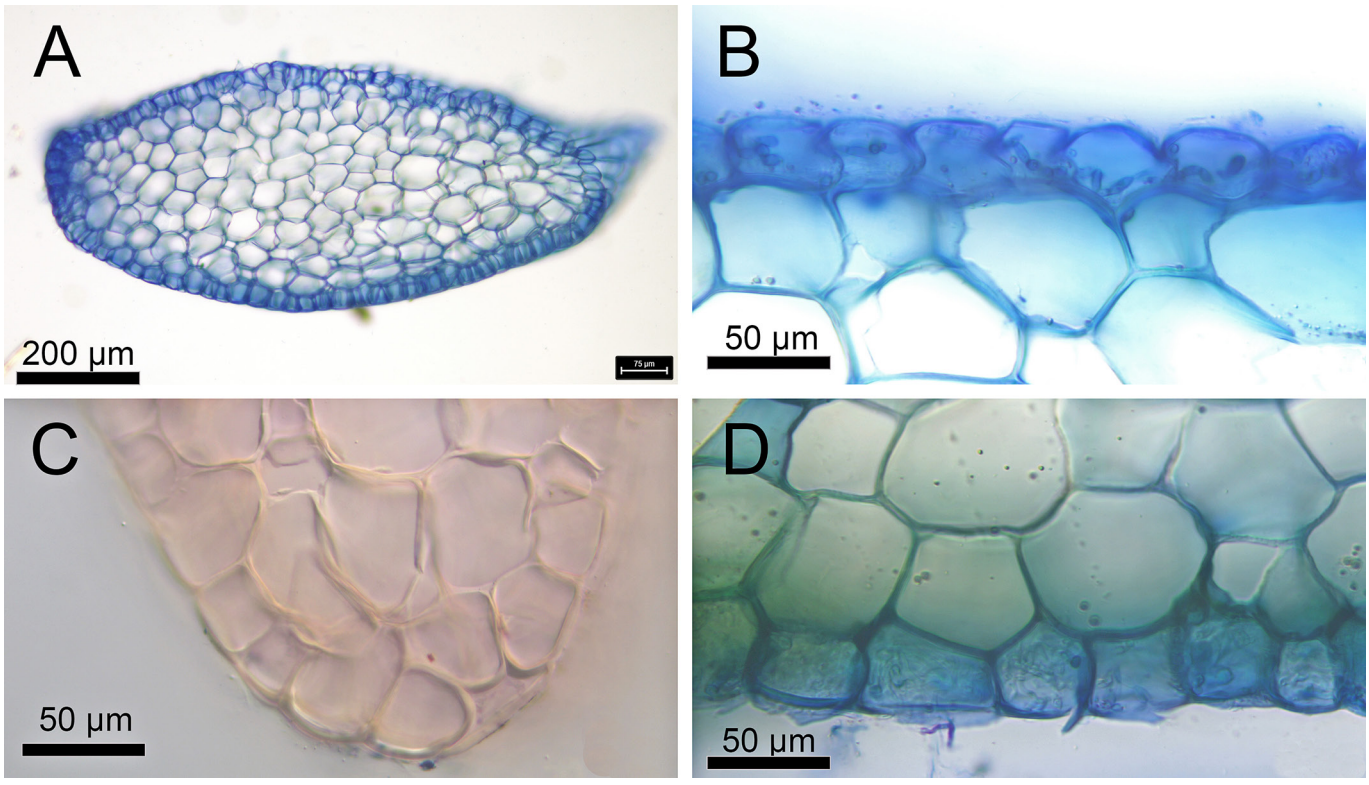

Figure 3. *Riccardia gynandra*, transverse sections of thallus. A. Section of main axis. B. Dorsal epidermis showing endomycorrhizal hyphae. C. Thallus margin showing lack of a unistratose wing. D. Ventral margin showing endomycorrhizal hyphae. All bleached and A, B, and D. stained with methylene blue. All from the type (*D. Glenny 14446*, CHR 657841).

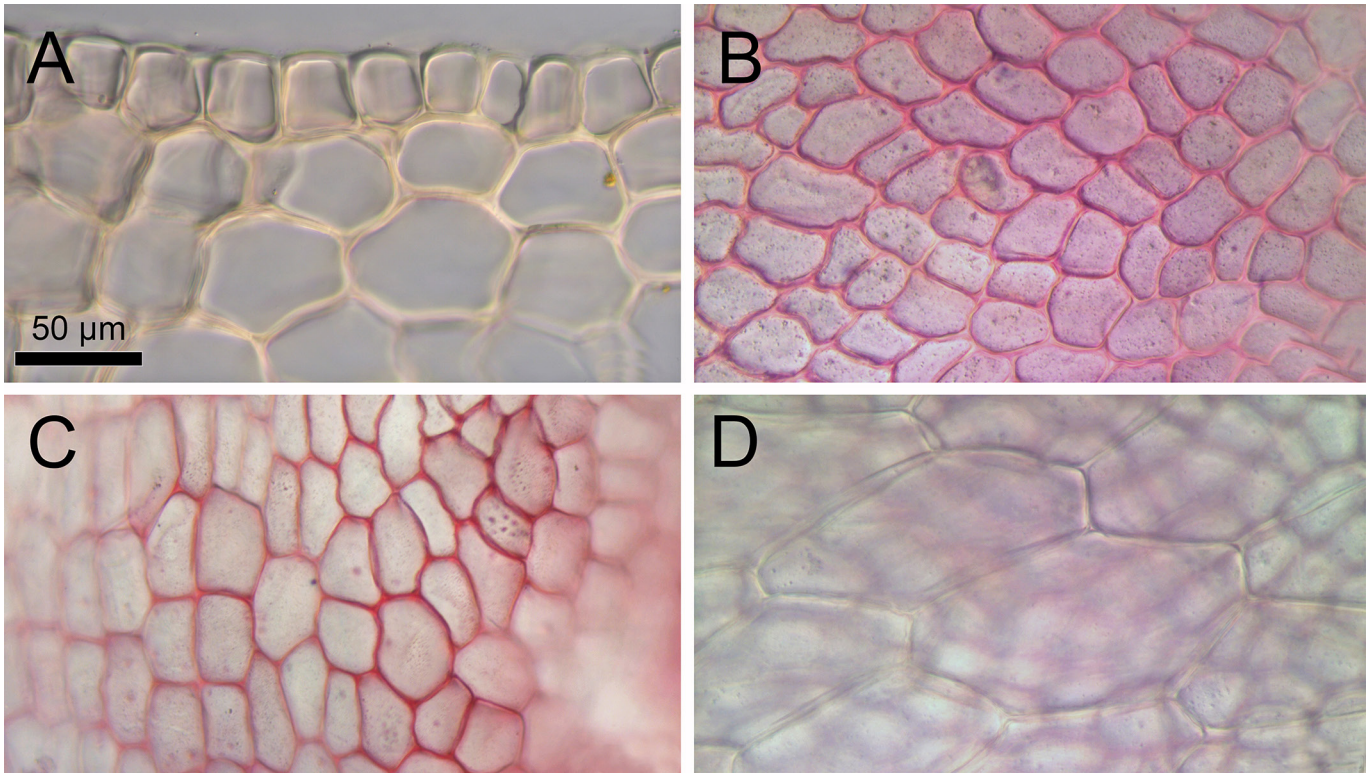

Figure 4. *Riccardia gynandra* thallus, dorsal and ventral epidermis and subepidermis. A. Transverse section showing relative size of epidermal and interior thallus cells and thickened epidermal cell walls. B. Dorsal epidermal cells. C. Ventral epidermal cells. D. Dorsal subepidermal cells. All from the type. All bleached, B and C stained with ruthenium red. 50 µm scale bar applies to all.

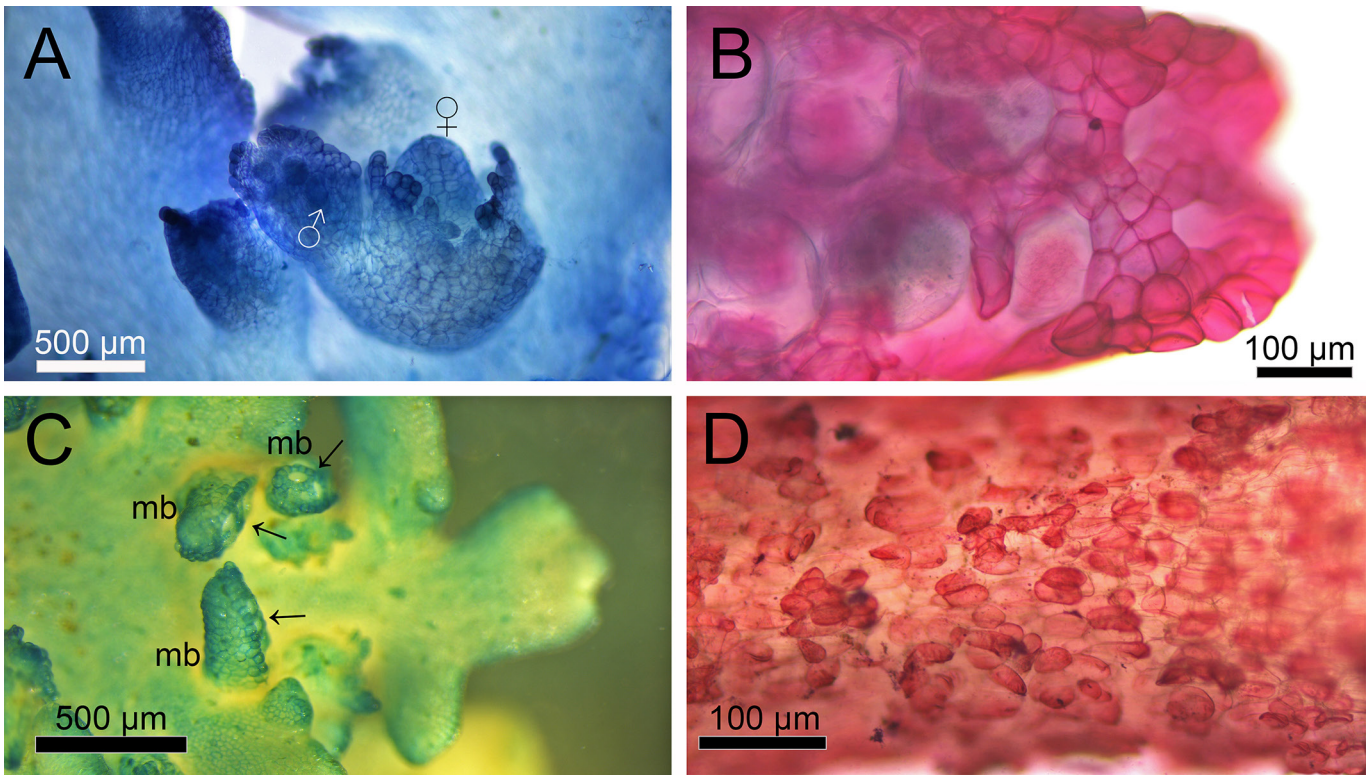

Figure 5. *Riccardia gynandra*, sexual branches and calyptra surface. A. Sympodial, bifid sexual branch with male and female indicated. B. Clathrate surface of male branch and apical notch. C. Ventral view of thallus surface showing male branches (mb) oriented downwards vertically, clathrate surfaces indicated by arrows. D. Pachydermal cells scattered on calyptra surface. All from the type. All bleached, A and C stained with methylene blue, B and D stained with ruthenium red.

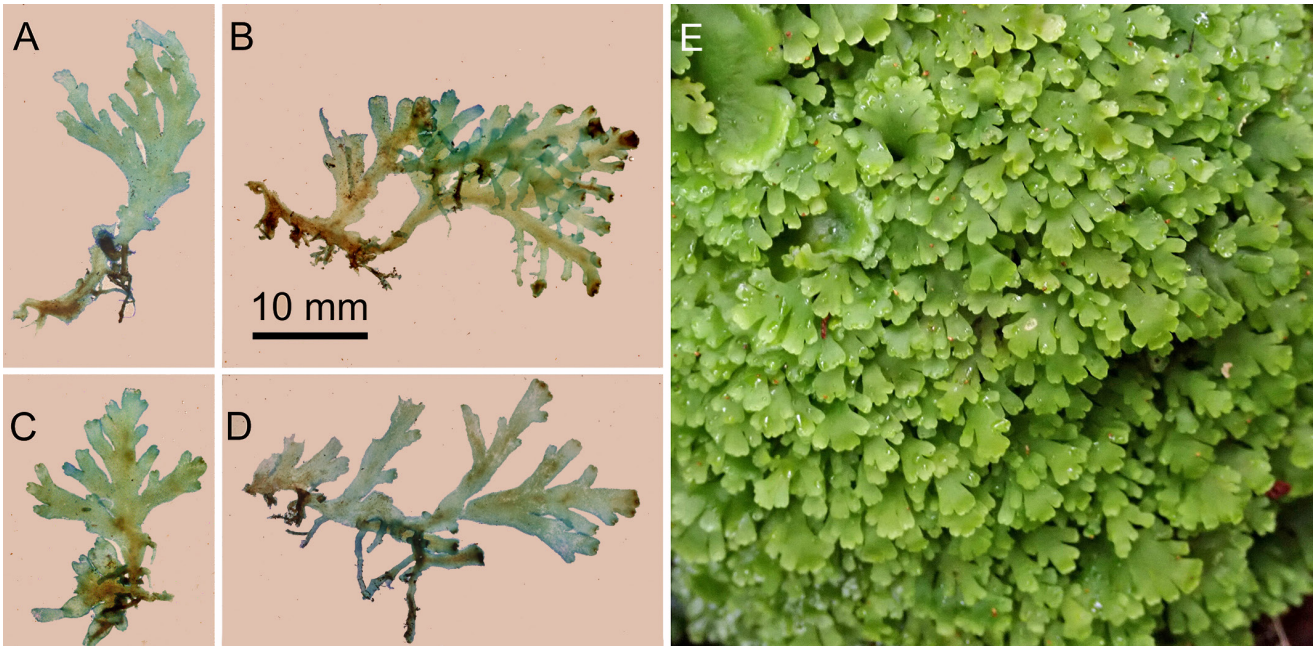

Figure 6. *Riccardia crassa*. A–D, Single primary shoots. E, Field view of the same primary shoots. Scale bar applies to A–D. A–D slightly bleached and stained with methylene blue. All from Northland, Waimā, Te Ramaroa (*M. Ford 2617*, CHR 703341).

Table 1 shows that the basic dimensions of the thalli of the two species (thallus width and depth) are very similar. Male branches in both are solitary or rarely with 2 or 3 divisions per branch.

Table 1. Comparison of key features of *Riccardia gynandra, R. crassa, and R. tenerrima*. Data on *R. crassa* from Brown and Braggins (1989), on *R. tenerrima* from Hässel de Menendez (1972).

	R. gynandra	*R. crassa*	*R. tenerrima*
Primary shoot length, mm	10–23	15–45	–40
Thallus width, µm	1150–1300	960–2250	1000–1500
Thallus depth, µm	310–480	(147)251–515(860)	200–250
Thallus depth, cells	9–12	7–11(14)	5–7
Epidermal cell size relative to internal cells	distinctly smaller, abruptly so	distinctly smaller, abruptly so	slightly to distinctly smaller, abruptly so when smaller
Branch apices	slightly emarginate	deeply notched	moderately emarginate
Mucilage papillae, length and width, µm.	53–77 × 20–32	97–450 × 21–63	98 × 26–31
Mucilage papillae, outer wall	smooth	striate	smooth
Mucilage papillae, persistence below the apex	persistent	occasionally persistent	persistent
Margin	unwinged	unwinged	unwinged
Endomycorrhizae	present in dorsal and ventral epidermis	rarely present	absent
Thallus surface ornamentation	smooth	strongly striate-verrucose	smooth
Sexuality	monoicous	diocious *	monoicous
Gemmae	absent	occasional	present
Stolons, presence	abundant	usually abundant	abundant
Stolons, origin	lateral and ventro-lateral from thallus margins	lateral and ventro-lateral from thallus margins	terminal on sexual branches
Rhizoids	infrequent on stolons and ventral surface	infrequent	on ventral surface of sexual branches
Position of male branches	margins of branches or sinuses between branches	main axis or stolons	main axis or branches
Position of female branches	margins of branches or sinuses between branches	main axis or stolons	main axis or branches
Division of male branches	solitary, rarely 2–3	solitary or 2–3	solitary or 2(3)
Antheridia per male branch division	2–10	8–12(16)	10–16(20)

*Brown and Braggins (1989) noted that one monoicous thallus was seen in a dioicous population of *R. crassa*.

Etymology: *Gynandra* — from Greek γυνή, γυναικός (gynē, gynaikos), "female." and ἀνήρ, ἀνδρός (anēr, andros), "male." The epithet refers to the distinctive sexual morphology of the species, in which male and female reproductive branches occur together in mixed clusters, often on the same branching system.

Conservation status: Data deficient (Townsend *et al*. 2008) as known from a single location, recently recognised and not listed by de Lange *et al*. (2015). *Riccardia gynandra* may prove to be more widespread in the south-west of the South Island and elsewhere on Rakiura, but this requires confirmation by dedicated search effort. *Stolonivector echioides* Frogley & Glenny (2020), for example, was found 11 km south of this site in similarly unremarkable forest and is also known from Architect Creek in South Westland.

Discussion: Male and female branches of *Riccardia gynandra* are usually separate but they may be fused and then sympodial but not synoicous. Synoicy in *Riccardia* was described and illustrated by Schuster (1992: 630–631 and fig. 877:6, 7 and 8, fig. 878:9, fig. 879:1 and 4) for *R. multifida* ssp. *synoica* R.M.Schust. Schuster (1992) discussed and illustrated sympodial gametangial branches in which a sexual branch divides with the divisions male and female. The synoicous branches are illustrated as having archegonia and antheridia on a shared surface on the same branch. His figures 877:4 and 7 shows three pairs of antheridia proximal and two archegonia distal on one branch. His figure 879:4 shows one antheridium and two archegonia in the same relative position, archegonia distal to the antheridium. Fertile branches are described and illustrated as facing dorsally and branching from the thallus margin and visible in dorsal view.

Riccardia gynandra does not have synoicous branches but mixed-sex sympodial branches are common. Fertile branches of both sexes are largely hidden from dorsal view by being ventro-lateral or ventral and are sessile.

Furuki (1991) described the male branches of *Riccardia flavovirens* as "strongly descending" whereas all other Japanese *Riccardia* species have male branches in the plane of the main axis. Furuki does not illustrate this feature and it is unclear whether they are the same as vertically descending male branches of *R. gynandra*.

Male branches of *Riccardia* can be on stolons and thus buried in soil [Furuki, 1991, citing *R. crassa, R. latifrons* (Lindb.) Lindb., and *R. marginata* (Colenso) Pearson) var. *marginata*], but the male branches in these species are lateral on the stolons and so are in the normal position. What differs is that stolons are branches are not flattened.

Acknowledgements

I thank Paul Corwin and Keith Murray for making the trip to Lords River by sea kayak possible in 2019. I thank John Engel and Stella Fish for their helpful reviews. I thank Marley Ford for his image and specimen of *Riccardia crassa*. This work was supported by the Ministry of Business, Innovation and Employment's Strategic Science Investment Fund.

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