

Three new species of *Calandrinia* (Portulacaceae) from the Eremaean and South West Botanical Provinces of Western Australia

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Abstract

Obbens, F.J. Three new species of *Calandrinia* (Portulacaceae) from the Eremaean and South West Botanical Provinces of Western Australia. *Nuytsia* 22(6): 351–362 (2012). Three new species in *Calandrinia* Kunth. sect. *Pseudodiantoideae* Poelln. are described: *C. hortiorum* Obbens, *C. umbelliformis* Obbens and *C. operta* Obbens. The first two species are located within the Eremaean Botanical Province while the last species has a disjunct distribution in both the Eremaean and South West Botanical Provinces.

Introduction

This paper describes three new species in *Calandrinia* Kunth. sect. *Pseudodiantoideae* Poelln. from Western Australia. There has been a significant increase in the number of new endemic calandrinias being discovered in Western Australia and this has spurred on endeavours to document their alpha taxonomy. All of the new species are currently phrase-named on Western Australia's plant census.

Methods

For each of the new species described, measurements were taken from dried pressed material or from material preserved in 70% ethanol. All spirit specimens were measured wet. Frequent large variations in plant size and in other morphological characters occur within the genus, both within and between populations due to environmental and seasonal conditions. Therefore, measurements are presented as ranges compiled from specimens of several populations across the species distribution and from both dried and spirit materials. Most measurements were made using a microscope graticule. Occasionally an estimate is given where an exact measurement was not possible. Stem, scape and inflorescence axis for *C. hortiorum* Obbens were measured as outlined in Obbens (2011: see Figure 12). However, a number of calandrinias display different architectural variations which do not fit well within this scheme. *Calandrinia umbelliformis* Obbens and *C. operta* Obbens display no obvious point to differentiate between stem and scape and were measured as one unit referred to here as the 'stem/scap shoot'. Even some smaller specimens of *C. hortiorum* do not always fit the above scheme and/or have extremely short stems within a rosette of basal leaves. Bracts on the inflorescence axis were measured flattened out, but shape is described for bracts *in situ*. Sepal shape was described and measurements taken *in*

situ on flowering specimens. Flowering times for each species are based on specimen collections or from field observations.

SEM images were produced at the Botanic Gardens and Parks Authority Biodiversity Conservation Centre using the Joel NeoScope JCM-5000 scanning electron microscope. Microscope parameters were: current 10 Kv and working distance 45 mm. Seed specimens were sputter coated with gold before scanning. Images were subsequently enhanced using Photoshop 2.0. Information regarding species distribution and mapping boundaries follows *Interim Biogeographical Regionalisation for Australia (IBRA) Version 6.1* (Department of the Environment, Water, Heritage and the Arts 2008).

Taxonomy

Calandrinia hortiorum Obbens, *sp. nov.*

Typus: c. 0.5 km south along Mullewa–Carnarvon Road from junction with the Pinegrove–Yallalong Road turnoff and just north of Bullardoo homestead, Shire of Mullewa, Western Australia, 16 September 2004, F. Obbens & F. Hort FO 57/04 (*holo*: PERTH 06981216; *iso*: CANB).

Calandrinia sp. Bullardoo (F. Obbens & F. Hort FO 57/04), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 8 February 2012].

Annual herb; prostrate, occasionally semi-erect to erect, 10–125 mm tall, 10–190 mm wide, glabrous, root system a small taproot, occasionally larger with several finer lateral roots. *Basal leaves* fleshy, spatulate to broadly obovate, occasionally depressed obovate or obtrullate, 2.9–35 mm long, 1.4–9.5 mm wide, with a prominent medial groove on adaxial surface, green, grey-green or reddish brown. *Stems* few to several (usually 1–10), 2–40 mm long, radiating from base, occasionally once-branched. *Stem leaves* fleshy, obovate to obtrullate sometimes spatulate, to 12 mm long and 6 mm wide, regularly with a shallow medial groove on adaxial surface and a distinctive mucron at apex, alternate, usually in small clusters at stem ends. *Scapes* 4–32 mm long, often with one residual leaf/bract midway and occasionally once to thrice-branched on larger specimens. *Inflorescence axis* 6–60 mm long, bare except for 3 to several ±scarious bracts, alternate soon becoming opposite on upper axis, generally forming a loose cyme. *Inflorescence axis bracts* appressed to ±spreading, triangular to broadly triangular, 0.9–3.3 mm long, 0.6–2.8 mm wide, apex acute to mucronate. *Pedicels* 2.5–11 mm long, to 17 mm long in fruit, moderately to strongly reflexed. *Flowers* 6–23 mm diam. *Sepals* thick, ovate to broadly ovate, 1.4–4.9 mm long, 1.4–4.4 mm wide, free to base, prominently 3–5 nerved. *Petals* 5, either bright mid-pink or creamy white, obovate to broadly obovate, with obvious notch at apex, 2.9–12.5 mm long, 2–7.5 mm wide, free to base. *Stamens* 10–51 in 1 to 3 rows (small flowers with 10 stamens have one row while larger flowers with more stamens have either two or three rows), usually alternating long and short (when one row) or with longer inner and shorter outer series (when 2 or 3 rows); filaments free, 1.1–2.7 mm long, attached to top of a basal ring beneath ovary, papillose on lower basal adaxial portion; anthers broadly elliptic to broadly oblong in outline, 0.3–0.9 mm long, 0.4–0.55 mm wide, versatile, extrorse, dehiscing longitudinally. *Ovary* obovoid, 1.1–1.7 mm diam., brown. *Stigmata* 3, ovate or squat-triangular, elongating, spreading slightly and becoming more linear with maturity, 0.6–1.3 mm long, free to base, with dense covering of relatively long stigma trichomes. *Capsule* ovoid to broadly ovoid, 2.6–4.9 mm long, 1.8–3.6 mm wide; apex obtuse, usually slightly protruding beyond sepals; valves 3, splitting from apex to base. *Seeds* 36–165, dark red-brown to almost black, semi-glossy, sub-reniform with distinct lateral bulges, 0.5–0.7 mm long, 0.5–0.65 mm wide, 0.4–0.5 mm thick, surface strongly patterned with moderately-sized colliculate structure, sometimes

with papillate rows on dorsal and side surfaces and also with minute pores at colliculate boundary junctions (only seen at high magnification). (Figures 1, 2)

Other specimens examined. WESTERN AUSTRALIA: c. 11 km N of Mt Mungada (Hinge prospect) on Gindalbie Mine Lease and c. 65 to 75 km directly NE of Perenjori town centre, 6 Sep. 2007, D. Coultas AS40 (PERTH); E side of Coolgardie North Rd, c. 7.4 km SSE Callion, ex Credo Station, 3 Sep. 2011, N. Gibson & M. Langley 5152 (PERTH); Mt Barloweerie survey site MTBW25, located on Mt Barloweerie (BIA Aboriginal Reserve), c. 7.2 km SE of Burra Burra Well and c. 9.6 km SW of Pia Well, c. 130 km NNW of Yalgoo, 29 Aug. 2008, R. Meissner & J. Wright 2081 (PERTH); N of Rothsay Rd and S of Mt Warriedar (Gindalbie lease area), 10 Sep. 2009, F. Obbens 05/09 (PERTH); just off Yalgoo–Paynes Find Rd (E side) Warriedar Station, 10 Sep. 2009, F. Obbens 07/09 (PERTH); 90.3 km N of Murchison Settlement on the Carnarvon–Mullewa Rd, 19 Aug. 2008, F. Obbens, F. Hort & J. Hort FO 18/08 (PERTH); 33.2 km E along the Beringarra–Byro Rd from the junction with the Carnarvon–Mullewa Rd, 20 Aug. 2008, F. Obbens, F. Hort & J. Hort FO 21/08 (PERTH); 41.6 km N along the Mullewa–Carnarvon Rd from the Greenough River Crossing, 16 Sep. 2008, F. Obbens, F. Hort & J. Hort FO 34/08 (PERTH); 8.2 km SE along Meeberrie–Mt Wittenoom Rd from junction with Boolardy–Wooleen Rd, 17 Sep. 2008, F. Obbens, F. Hort & J. Hort FO 39/08 (PERTH); 74.6 km S along the Morawa–Yalgoo Rd from the junction with the Geraldton–Mt Magnet Rd, 18 Sep. 2008, F. Obbens, F. Hort & J. Hort FO 49/08 (PERTH).

Distribution. Occurs in a relatively wide area of the Eremaean Botanical Province, mostly in the Yalgoo and western Murchison bioregions and with a disjunct collection from the Coolgardie bioregion (Figure 3).

Habitat. Mostly found on erosional landscapes such as breakaways, crests, lower slopes and rocky outcrops, often growing in soil-filled cracks or shallow soil pockets containing residual lateritic or ferricrete material over exposed and decaying granitic basement rock. Some sites have better developed soils or more rarely lateritic cap rock. Most sites have brown or red-brown sandy clay loams, often gritty or with gravels or stones. The preferred vegetation community for *C. hortiorum* is herbfield associated with open tall shrubland over open smaller shrubs. There is a wide variety of associated species over the species' distribution with acacias most common; such as *Acacia tetragonophylla*, *A. cuthbertsonii*, *A. aulacophylla*, *A. grasbyi*. Other species from various sites include *Senna artemisioides*, *Eremophila latrobei*, *Grevillea extorris*, *Ptilotus obovatus*, *Aristida contorta* and *Pogonolepis stricta*.

Phenology. Flowers from mid-August to late September.

Conservation status. This taxon is quite common, but probably under-collected. Currently there are 15 collections at PERTH from localities extending from 90 km north of the Murchison Settlement southwards towards Paynes Find with a disjunct record further east towards Kalgoorlie. It is likely to be more widespread.

Etymology. Named after Fred and Jean Hort who brought this species to my notice. They were also instrumental in surveying the distribution of this species and a number of other recently phrase-named calandrinias.

Notes. The relationships of *C. hortiorum* are unclear. It has sub-reniform seeds with a strong colliculate pattern superficially similar to *C. polyandra*, but in other respects is very different from that species. Flowers in the most northerly populations are predominantly creamy white on their inner surface,



Figure 1. Holotype of *Calandrinia hortiorum* (F. Obbens & F. Hort FO 57/04, PERTH 06981216). Scale bar = 5 cm.

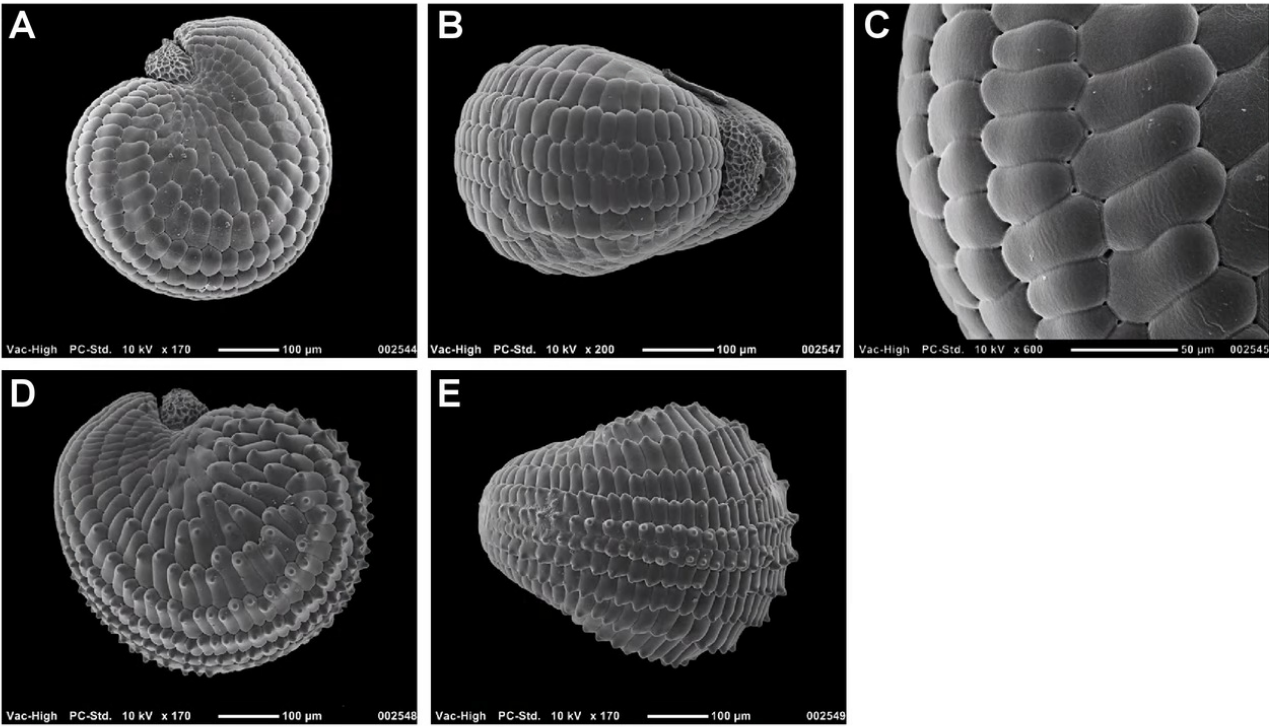


Figure 2. SEM of *Calandrinia hortiorum* seeds. Southern variant. A – plan view; B – dorsal view; C – surface pattern at higher magnification displaying micro-pores at the colliculate boundary junctions (*F. Obbens* & *F. Hort* FO 57/04). Northern variant. D – plan view; E – dorsal view (*F. Obbens*, *F.* & *J. Hort* FO 21/08). Scale bars A, B, D, E = 100 µm; C = 50 µm.

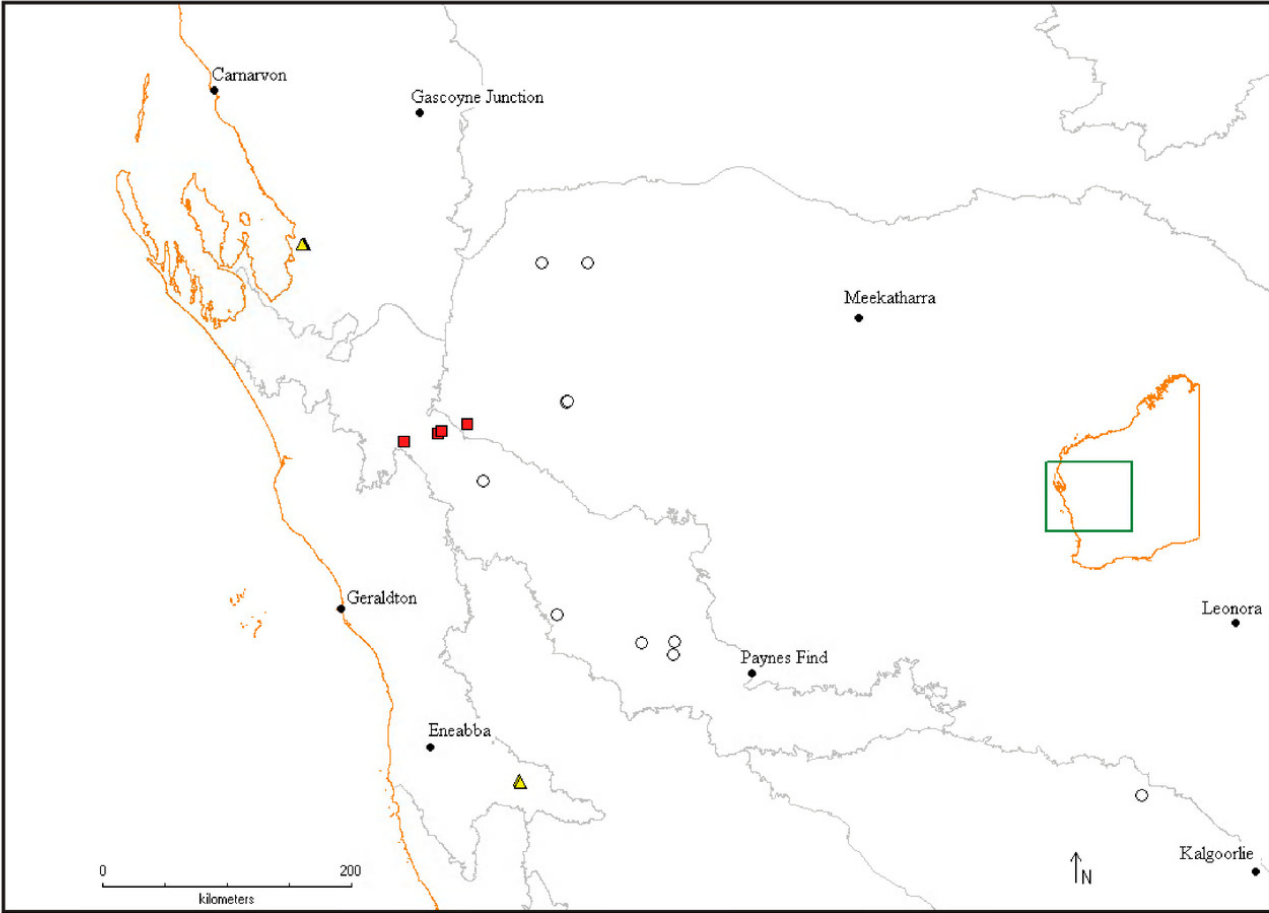


Figure 3. Distribution of *Calandrinia hortiorum* ○, *C. umbelliformis* ■ and *C. operta* ▲ in Western Australia.

sometimes very light pink or pink-tinged. The petal abaxial surfaces are frequently pale yellow and appear yellowish in bud. Seeds from northern populations often have dorsal rows of papillae, but these are much less apparent, if present at all, on southern collections. Flowers in the southern populations are predominantly mid to darker pink although white-coloured variants do occur irregularly. In these populations, the petals abaxially are usually dull white or occasionally with yellow or reddish-pink reticulate markings and usually appear pink with some white in bud. Because this species is poorly known the differences between northern and southern populations cannot yet be fully evaluated. Therefore, it is too early to suggest any infraspecific taxa, but this may be a consideration for the future.

Calandrinia umbelliformis Obbens, *sp. nov.*

Typus: Coolcalalaya Road, Mullewa, Western Australia [precise locality withheld for conservation reasons], 6 October 2004, *F. Hort, J. Hort & J. Shanks* 2347 (*holo*: PERTH 06924905; *iso*: CANB).

Calandrinia sp. Coolcalalaya (G.J. Keighery & N. Gibson 698), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 8 February 2012].

Annual herb; prostrate to decumbent, 10–40 mm tall, 20–115 mm wide, glabrous, root system a small taproot with several finer lateral roots. *Basal leaves* fleshy, obovate to broadly obovate, 3.4–21.5 mm long, 1.8–9.4 mm wide, with a shallow medial groove on adaxial surface of larger leaves, green, red-green or red. *Stem/scape shoots* few to several (usually 2–12), 10–55 mm long, leafless for first 2.5–17.5 mm from base with remainder very leafy, radiating from base, frequently branched two to several times. *Stem/scape shoot leaves* fleshy, obovate to orbicular, occasionally broadly so, to 17 mm long and 7.8 mm wide, often with a shallow medial groove on adaxial surface and a distinctive mucro at apex, alternate to sub-opposite, rarely whorled or clustered. *Inflorescence axis* 5–12 mm long, bare except for 3 to several ±scarious bracts, usually with pedicels and accompanying bracts tightly contracted onto a short portion of axis forming an umbel-like inflorescence. *Inflorescence axis bracts* appressed to ±spreading, narrowly triangular, 0.6–2.7 mm long, 0.4–1.2 mm wide, apex often mucronate and recurved. *Pedicels* 1.5–6 mm long, erect, usually tightly clustered together, to 7.5 mm long in fruit, slightly reflexed. *Flowers* 6–11 mm diam. *Sepals* thick, broadly ovate, 1.5–3.8 mm long, 1.4–2.7 mm wide, free to base, mid-nerve prominent, others less so. *Petals* 5, white-cream, often light yellowish when dried, obovate to broadly obovate, 2.5–4 mm long, 1.9–3.5 mm wide, free to base. *Stamens* 24–37 in 2 rows, generally in a longer inner series and a shorter outer series; filaments free, 1.1–1.9 mm long, attached to top of a basal ring beneath ovary, usually significantly flared and papillose on lower basal adaxial portion; anthers elliptic to oblong in outline, 0.45–0.6 mm long, 0.35–0.5 mm wide, versatile, extrorse, dehiscing longitudinally. *Ovary* obovoid to broadly obovoid, 1.3–1.5 mm diam., brown. *Stigmata* 3, ovate to triangular, elongating and becoming more linear with maturity, 0.4–1.2 mm long, free to base, densely covered with moderately long stigma trichomes. *Capsule* ovoid, occasionally broadly so, 1.7–2.5 mm long, 1.3–2 mm wide; apex obtuse, usually slightly protruding beyond sepals; valves 3, splitting from apex to base. *Seeds* 46–104, light brown to mid-tan, glossy, obovoid to narrowly obovoid, 0.3–0.5 mm long, 0.2–0.4 mm wide, 0.2–0.3 mm thick, essentially smooth (i.e. there is no surface pattern at low magnification, but at high magnification a very light colliculate structure is detectable near strophiole). (Figures 4, 5)

Other specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 6 Oct. 2004, *F. Hort, J. Hort & J. Shanks* 2350 (PERTH); 6 Oct. 2004, *F. Hort, J. Hort & J. Shanks* 2354 (PERTH); 2 Sep. 1995, *G.J. Keighery & N. Gibson* 698 (PERTH).

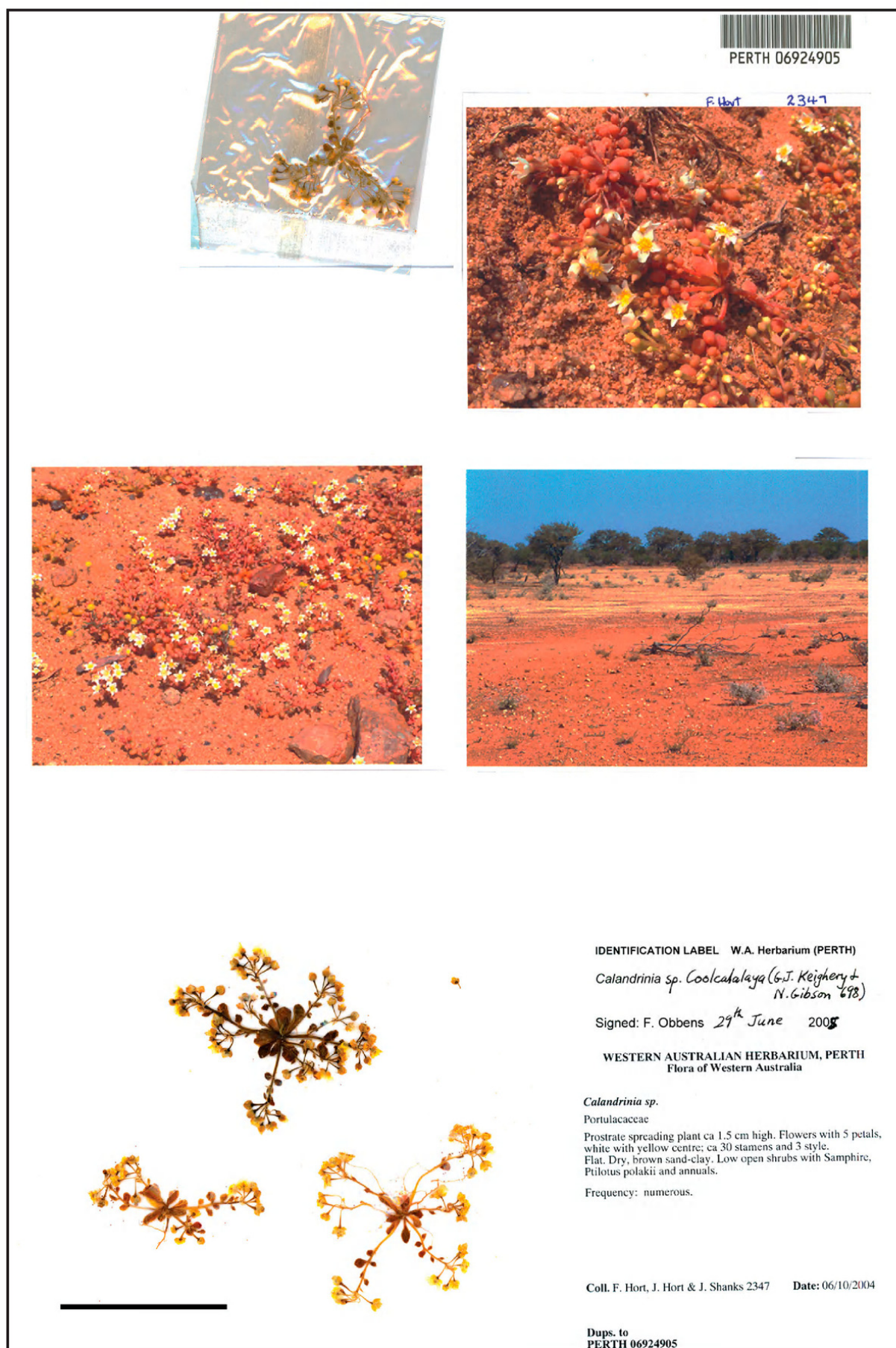


Figure 4. Holotype of *Calandrinia umbelliformis* (F. Hort, J. Hort & J. Shanks 2347, PERTH 06924905). Scale bar = 5cm.

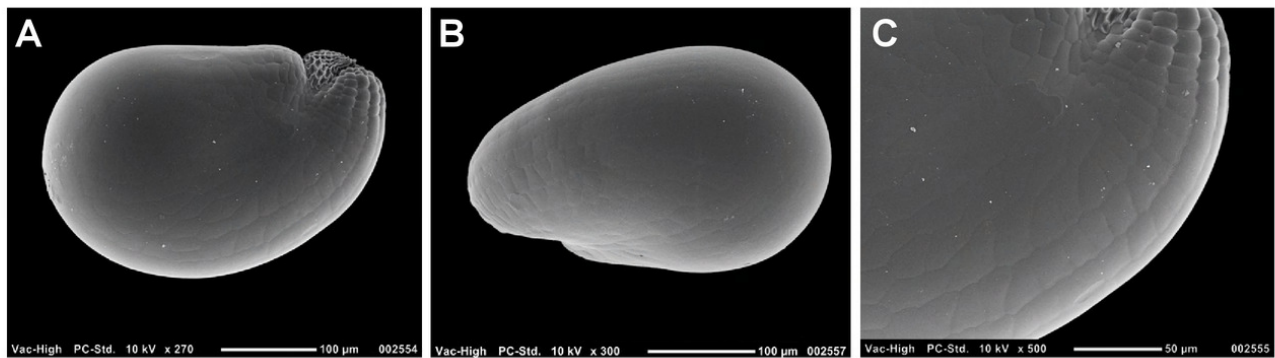


Figure 5. SEM of *Calandrinia umbelliformis* seed. A – plan view; B – dorsal view; C – surface at higher magnification (F. Hort, J. Hort & J. Shanks 2347). Scale bars A, B = 100 µm; C = 50 µm.

Distribution. Currently known from a very small area of the Yalgoo and western Murchison bioregions within the Eremaean Botanical Province. All known sites are within a small section of the Murchison River catchment on two adjoining pastoral leases (Figure 3).

Habitat. Claypan and flats are the only landforms where this species has been found. Some sites are semi-saline with brown sandy clay or loam while the claypan site has red clay soils. All sites are herbfield communities under or adjacent to open shrubland. One site is described as dense *Melaleuca* sp. and *Acacia tetragonophylla* surrounding a circular zone of mixed herbs, while two semi-saline sites have low shrubs such as *Ptilotus polakii* with samphires and other annuals. The last site is described as *Acacia* open shrubland.

Phenology. Flowers from early September to early October.

Conservation status. Currently four collections are held at PERTH from a very restricted area on two adjoining pastoral leases. Listed as Priority One under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora under the phrase name *C. sp. Coolcalalaya* (G.J. Keighery & N. Gibson 698) (Smith 2012).

Etymology. The species epithet derives from the umbel-like inflorescences that frequently occur on this taxon.

Notes. The seed shape and surface pattern of *C. umbelliformis* is quite similar to that of *C. pumila* although the seeds of *C. umbelliformis* are slightly smaller. The two species share no other obvious similarities, however, an obvious difference between them is that the seeds of *C. umbelliformis* disperse via capsule valves while those of *C. pumila* are basally circumscissile. The affinities of *C. umbelliformis* are uncertain.

The identity of *C. umbelliformis* has been the cause of confusion. The species was first collected in 1995 by Keighery and Gibson as part of the Carnarvon Basin Survey. They collected a yellow-flowered *Calandrinia* which was given the phrase name *C. sp. Coolcalalaya* (G.J. Keighery & N. Gibson 698). In the years following, a dozen or more further collections were made from a relatively wide area, and these were included under the above phrase-name. While reviewing the taxonomy of this species, it was revealed that these collections comprised more than one taxon. The original collection was of early flowering material and a detailed examination of the specimen found one small, poorly-developed capsule and several seeds, only two mature enough to discern their obovoid shape and light brown/tan colour. Other collections under this name had a different habit, seed shape and colour and were more widely distributed.

During fieldwork at Keighery and Gibson's original collection site, a bright yellow-flowered species and a white/creamy-flowered species were found to co-occur. The latter species matches the reference specimen for *C. sp.* Coolcalalaya (G.J. Keighery & N. Gibson 698). Its flowers often appear light yellowish when dried and its distribution is restricted. However, the former species appears to have become associated with this phrase-name in subsequent years. To resolve this situation, the more widespread yellow-flowered entity was given the phrase-name *C. sp.* Murchison-Gascoyne (F. Obbens & F. Hort FO 49/04) and subsequently described as *C. flava* Obbens (Obbens 2011).

Calandrinia operta* Obbens, *sp. nov.

Typus: Pinjarrega Nature Reserve, Western Australia, [precise locality withheld for conservation reasons], 8 October 2008, *W. Chow & S. Downes* Bent 18 WC03 (*holo*: PERTH 08172781; *iso*: CANB).

Calandrinia sp. Woodleigh (G.J. Keighery & N. Gibson 961), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed 8 February 2012].

Annual herb; semi-erect to erect, occasionally prostrate, 10–50 mm tall, 5–150 mm wide, glabrous, root system a weak taproot with several very fine lateral roots. *Basal leaves* fleshy, narrowly obovate to linear, sometimes mucronate, 4.5–21.5 mm long, 0.9–5.5 mm wide, with a shallow medial groove on adaxial surface of larger leaves, green soon turning dull red upon early flowering. *Stem/scape shoots* few to several (usually 3–9), 8.5–72 mm long, radiating out and upwards from base, occasionally once or twice branched. *Stem/scape shoot leaves* fleshy, narrowly obovate to obovate, to 11.4 mm long and 4.7 mm wide, with a prominent mucro at apex, alternate, some occasionally forming loose leaf clusters. *Inflorescence axis* 6.5–58 mm long, bare except for 3 or more ±scarious to membranous alternate bracts along its length with opposite paired bracts at each pedicel on upper axis, generally forming a loose cyme. *Inflorescence axis bracts* appressed to ±spreading, narrowly triangular to triangular, 1–2.7 mm long, 0.35–1.8 mm wide, apex acute to mucronate. *Pedicels* 1.8–5.5 mm long, erect, to 10.5 mm long in fruit, moderately to strongly reflexed. *Flowers* 2–3.5 mm diam., ±campanulate, never fully open. *Sepals* moderately thick, ovate to broadly ovate, 2.2–3.5 mm long, 1.7–3.8 mm wide, free to base; mid-nerve prominent with 3 to 5 nerves less obvious and some reticulation. *Petals* 5, pale yellow, elliptic to obovate, often with a depressed apex, 1.8–2.3 mm long, 0.8–1.8 mm wide, free to base. *Stamens* 5–11 usually in 1 row alternating long and short, occasionally 1 row of 8 stamens with 3 stamens slightly offset or two lots of 3 stamens clustered on opposite sides of the ovary; filaments free, 0.9–1.3 mm long, attached to top of a basal ring beneath ovary, papillose on lower basal adaxial portion; anthers transversely elliptic to transversely oblong in outline, 0.2–0.35 mm long, 0.3–0.35 mm wide, versatile, extrorse, dehiscing longitudinally. *Ovary* spheroid to ovoid, 0.7–1.1 mm diam., brown. *Stigmata* 3, ovate to triangular, elongating and becoming more linear with maturity, 0.3–0.8 mm long, free to base, with a moderate covering of long stigma trichomes. *Capsule* ovoid, 2–3.2 mm long, 1.4–2.3 mm wide; apex obtuse, usually equal to or less than sepals; valves 3, splitting from apex to base. *Seeds* 13–29, dark brown/tan to almost black, glossy, orbicular, 0.7–0.8 mm long, 0.6–0.75 mm wide, 0.3–0.35 mm thick, smooth, occasionally with surface nearer edges lightly colliculate. (Figures 6, 7)

Other specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 22 Aug. 1995, *G.J. Keighery & N. Gibson* 961 (PERTH); 29 Aug. 2009, *F. Obbens* 03/09 (PERTH); 1 Sep. 2010, *F. Obbens & A. Marais* FO 04/10 (PERTH); 23 Sep. 2011, *F. Obbens, F. Hort & J. Hort* FO 06/11 (PERTH).

Distribution. Occurs at two nearby locations in the Shark Bay area (Eremaean Botanical Province) and also at two nearby locations north-north-west of Watheroo (South West Botanical Province). This represents an extremely disjunct distribution of roughly 450 km (Figure 3).

Habitat. Northern collections have been found on saline pans or drainage lines on calcareous geology. The soils here are light brown sandy loams which carry samphire or low scrub communities over herbs. Typical associated species include: *Maireana oppositifolia*, *Tecticornia disarticulata*, *Atriplex lindleyi* subsp. *inflata*, *Sclerolaena recurvicauspis*, *Pogonolepis muelleriana* and *Hemichroa diandra*. The southern populations occur on the fringes of ephemeral bentonite lakes on a grey silty loam in open tall shrubland of *Allocasuarina huegeliana* and *Acacia* sp. over herbs including *Pogonolepis stricta*, *Gnephosis* sp. and some annual weeds.

Phenology. Flowers from mid-August to early October, although the northern populations are usually finished by early September.

Conservation status. Currently five collections are held at PERTH from two very disjunct localities (i.e. the Shark Bay and Watheroo areas). Searches for more populations around lakes on the Eneabba sandplains and sites within 20 km of the original collection within the Shark Bay area have had no success. Listed as Priority One under DEC Conservation Codes for Western Australian Flora under the phrase name *C. sp.* Woodleigh (G.J. Keighery & N. Gibson 961) (Smith 2012). All populations are under immediate threat either from grazing by stock or increasing salinity. This taxon should be the subject of more searches and may deserve a higher conservation ranking.

Etymology. The specific epithet refers to the 'hidden or concealed' (L: *opertus*) opening of the flowers.

Notes. Currently, the relationships of *C. operta* are unknown, however, the capsules are superficially similar to *C. eremaea* and the seeds are almost identical to *C. calyptrata*. In most other respects *C. operta* is quite different from these two species. *Calandrinia operta* does not appear to be closely related to the other yellow-flowered species, *C. flava*, even though their distributions somewhat overlap. Apart from being the second yellow-flowered *Calandrinia* to be described, this species is distinctive in having flowers which do not fully open. The maximum opening is approximately 3 mm diam. (see Figure 8).

When the original Keighery and Gibson collection from the Shark Bay area was recognised as a new taxon, the location was thought to be on Woodleigh Station, hence the phrase-name. Only later was it found that the actual site was on an adjoining pastoral lease, Yaringa Station. In fact, this taxon is more likely to be discovered on Carbla Station (adjoining to the south) or Wooramel Station (adjoining to the north) rather than on Woodleigh Station because those two stations have a somewhat similar geology and vegetation to Yaringa Station while Woodleigh Station, further inland, is quite different.

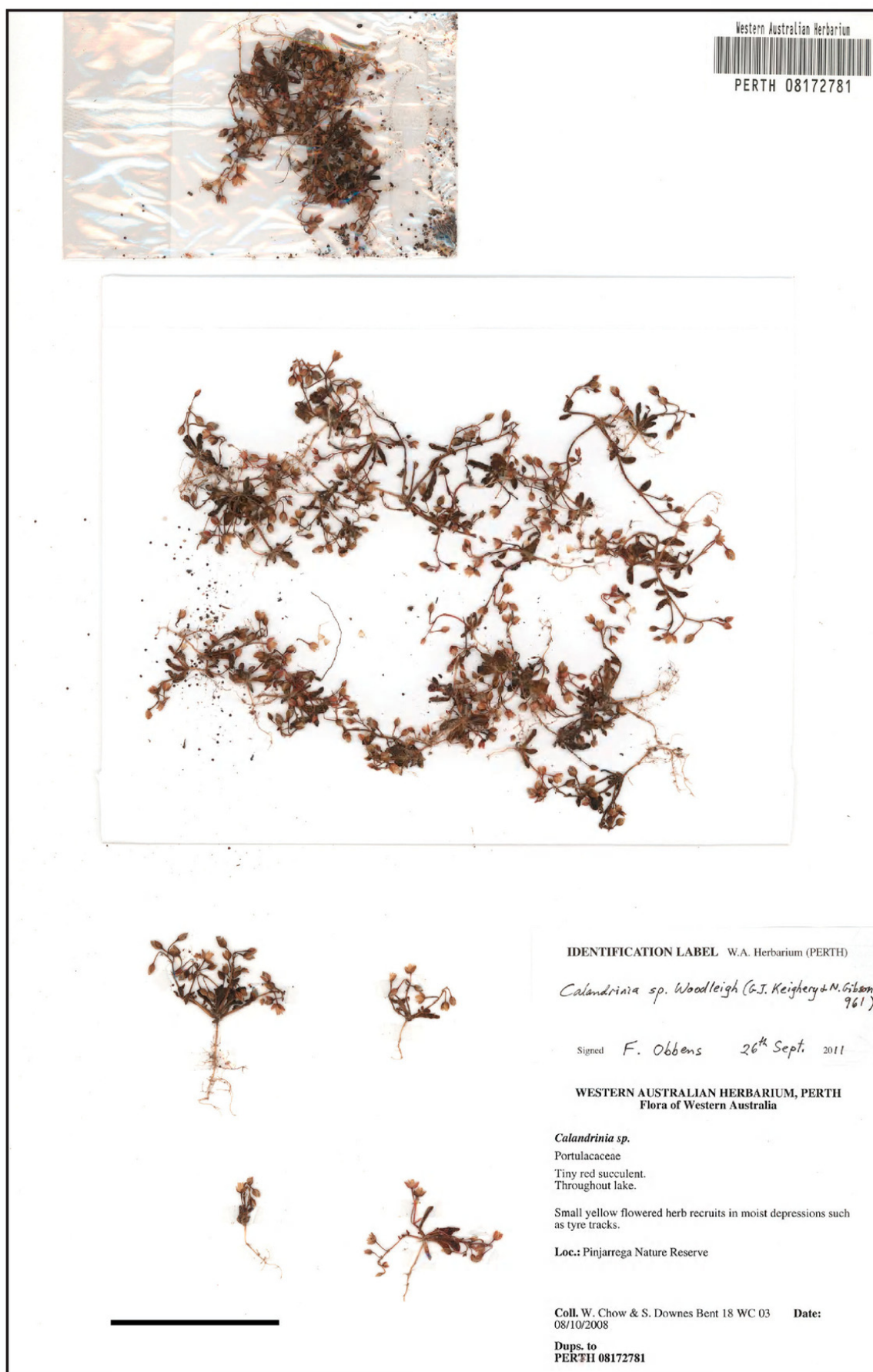


Figure 6. Holotype of *Calandrinia operta* (W. Chow & S. Downes Bent 18 WC03, PERTH 08172781). Scale bar = 5 cm.

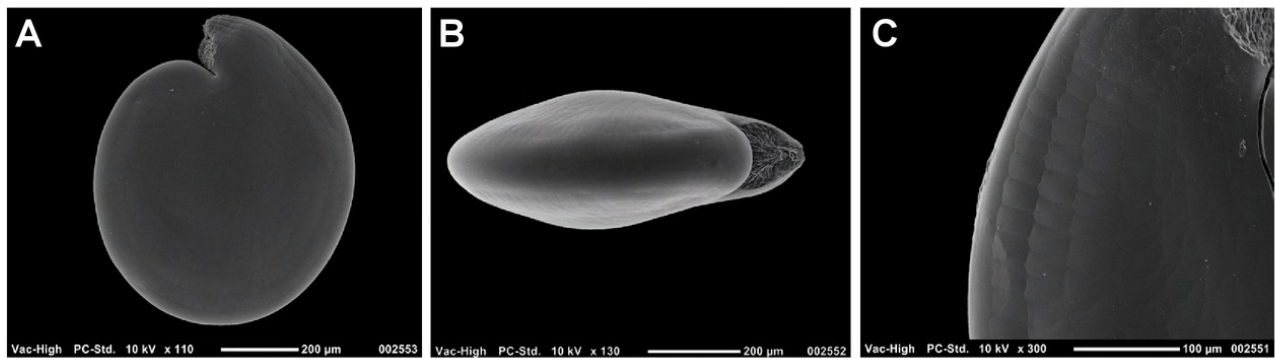


Figure 7. SEM of *Calandrinia operta* seed. A – plan view; B – dorsal view; C – surface at higher magnification (W. Chow & S. Downes Bent 18 WC03). Scale bars A= 200 µm; B = 200 µm; C = 100 µm.



Figure 8. *Calandrinia operta*. A – whole plant with open flower; B – close-up of fully opened flowers. Images: Wendy Chow, taken at the type locality in 2011.

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