

Calytrix calingiri, a new species from the *Calytrix acutifolia* species group (Myrtaceae: Chamelaucieae)

Francis J. Nge^{1,2,3} and Kevin R. Thiele^{4,5,6}

¹School of Biological Sciences, Faculty of Science,
The University of Adelaide, Adelaide, SA 5000, Australia

²State Herbarium of South Australia, Adelaide, SA 5005, Australia

³Current address: IRD – Institut de Recherche pour le Développement,
Avenue Agropolis BP 64501, Montpellier, France 34394

⁴Western Australian Museum, 49 Kew Street,
Welshpool, Western Australia 6106, Australia

⁵School of Biological Sciences, University of Western Australia,
35 Stirling Hwy, Crawley WA 6009

⁶Corresponding author, email: kevin.thiele@science.org.au

Abstract

Nge, F.J. & Thiele, K.R. *Calytrix calingiri*, a new species from the *Calytrix acutifolia* species group (Myrtaceae: Chamelaucieae). *Nuytsia* 33: 251–261 (2022). A taxonomic assessment of *Calytrix cravenii* Nge & K.R.Thiele has shown that a distinct morphological variant that occurs near Calingiri in south-west Western Australia is best regarded as a distinct species. It is described here as *Calytrix calingiri* Nge & K.R.Thiele *sp. nov.*

Introduction

Calytrix acutifolia (Lindl.) Craven was segregated into four species in a recent revision of the group by Nge *et al.* (2017). Species within the group lack awns and have white flowers with elongate inflorescences. All four species are endemic in southwest Western Australia and form a monophyletic clade within *Calytrix* based on molecular sequence data (Nge *et al.* 2021). The clade diverged from other *Calytrix* species during the late Miocene (*c.* 10 Ma; Nge *et al.* 2021).

Among the species in the group, *Calytrix cravenii* Nge & K.R.Thiele is most variable in leaf and floral morphology (Nge *et al.* 2017). Specimens from the Calingiri area with distinctly short leaves, petals, and hypanthia were discussed by Nge *et al.* (2017) and tentatively placed within *C. cravenii* pending further study.

Here we assess morphological variation in *C. cravenii* in more detail, both in the field and through morphometric assessment of herbarium specimens, and conclude that the Calingiri specimens are distinct from other populations of *C. cravenii* and its relatives, and are best regarded as representing a fifth species in the group. We provide an updated key to the *C. acutifolia* species group and recircumscribe *C. cravenii* to exclude the Calingiri taxon.

Methods

All available herbarium specimens of *Calytrix cravenii* housed at PERTH were examined to compare morphological variation across its distributional range and assess the distinct morphological variant at Calingiri. Seven leaf and floral characters were measured from representative specimens for quantitative analysis (Table 1), including leaf length and width, petal length, style length, bracteole length, and hypanthium length. Leaf length:width and hypanthium length:bracteole length ratios were calculated. Three measurements were made of each character per specimen using a microscope reticule to the nearest 0.01 mm and average values calculated for each measured specimen.

Morphometric analyses were performed using the Euclidean Distance dissimilarity measure after all characters were range-standardised. Unweighted pair group method with arithmetic mean (UPGMA) clustering and Principal Component Analysis (PCA) ordinations were performed in R (R Core Team 2016) using the `plot.hc` and `prcomp` functions respectively.

Results and Discussion

Both the UPGMA and PCA analyses showed that the Calingiri plants are distinct from typical *C. cravenii* (Figure 1), being distinctly smaller in all measured parts (Table 2). Floral characters are more taxonomically informative than leaf characters in separating the two entities, particularly hypanthium and bracteole lengths and their ratios. While the Calingiri plants overlap slightly in leaf characters with typical *C. cravenii*, they all have consistently shorter leaves than most *C. cravenii*.

Field observations show that the Calingiri plants also differ from typical *C. cravenii* in habit and growth form. The latter grow as abundantly multi-stemmed shrubs that appear to resprout after fire and other disturbances. By contrast, the Calingiri plants are single-stemmed at least when young, and are likely to be obligate reseeder after fire. Very old plants become multi-stemmed at ground level, but not by the growth of new shoots from the rootstock as was observed in *C. cravenii*. Instead, the single stem seen in young plants appears to exhibit anomalous secondary thickening, with broad parenchyma rays in the secondary wood, which cause it to split ground level as the plants get larger. Single-stemmed plants becoming multi-stemmed by splitting in this way have been observed in other genera and families (e.g. *Hibbertia*, some Myrtaceae); this unusual stem morphology is worthy of further investigation.

The two species appear to have different flowering times, with typical *C. cravenii* mostly in bud when the Calingiri plants are at peak flowering.

One specimen from Collie (*L. Dodd s.n.* PERTH 02157195) falls within the group comprising the Calingiri form in both the UPGMA and PCA analyses (Figure 1) but is geographically widely disjunct. It is also somewhat disjunct from typical *C. cravenii*. The specimen was collected from a road verge, and the collector speculated that it may have been introduced to the area. Field visits are required to determine the taxonomic status of the population or individual. It is tentatively assigned to the Calingiri form here, pending further studies.

Given the consistent differences between *C. cravenii* and the Calingiri form, we recognise the latter as the new species *Calytrix calingiri* Nge & K.R.Thiele, and recircumscribe *C. cravenii* to exclude it.

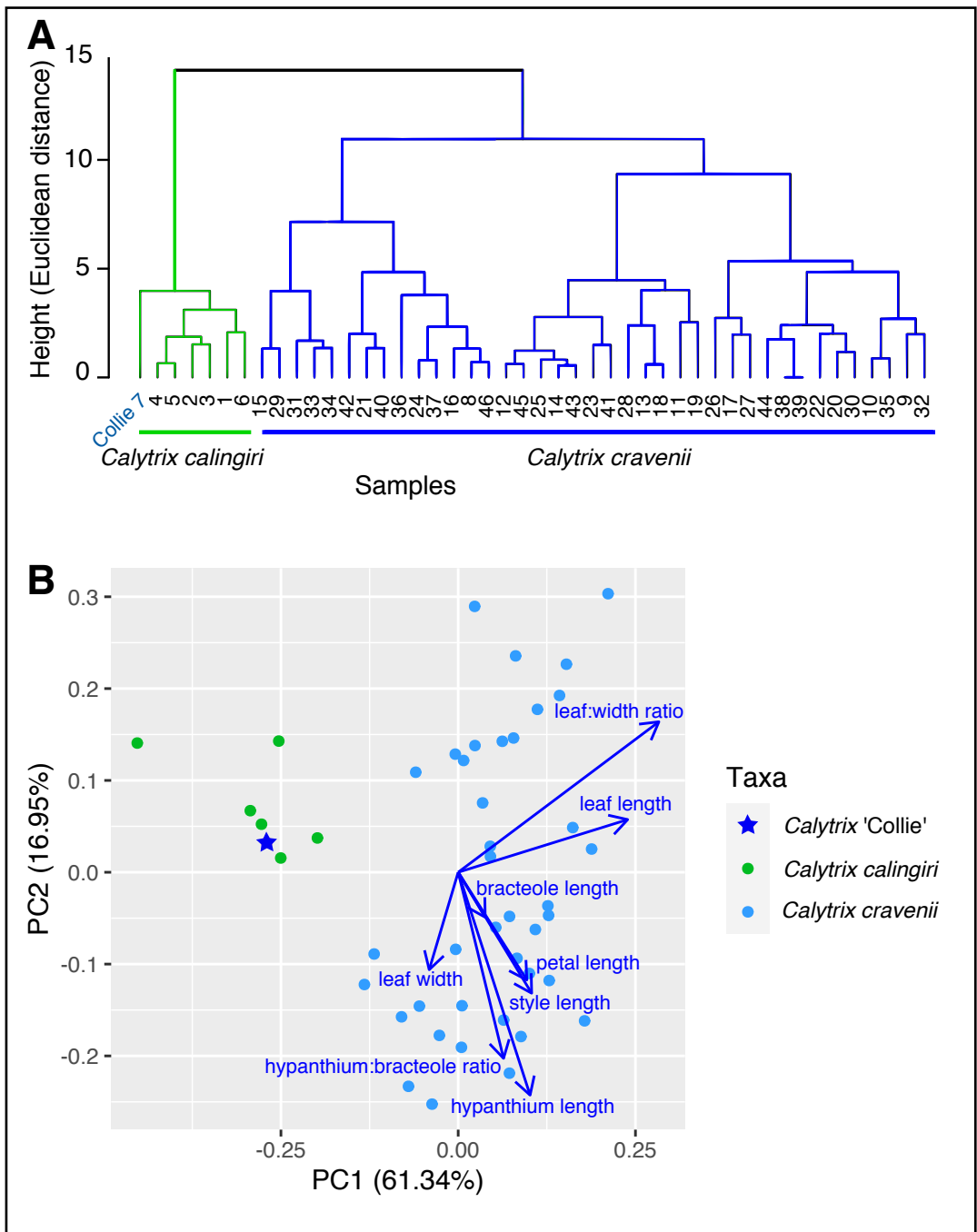


Figure 1. Morphometric analyses of floral and leaf characters from PERTH herbarium specimens of *C. calingiri* and *C. cravenii*. A – Unweighted pair group method with arithmetic mean (UPGMA) dendrogram; B – 2D Principal Components Analysis (PCA) ordination analysis, with arrows indicate the respective character and direction of separation between clusters.

Table 1. PERTH voucher specimens measured and included in Unweighted pair group method with arithmetic mean (UPGMA) and Principal Components Analysis (PCA) ordination analyses.

Number	Taxa	Voucher
1	<i>Calytrix calingiri</i>	PERTH 02157071
2	<i>Calytrix calingiri</i>	PERTH 02157160
3	<i>Calytrix calingiri</i>	PERTH 02157276
4	<i>Calytrix calingiri</i>	PERTH 06060935
5	<i>Calytrix calingiri</i>	PERTH 07185367
6	<i>Calytrix calingiri</i>	PERTH 08430357
7	<i>Calytrix</i> ‘Collie’	PERTH 02157195
8	<i>Calytrix cravenii</i>	PERTH 01179926
9	<i>Calytrix cravenii</i>	PERTH 01232649
10	<i>Calytrix cravenii</i>	PERTH 01560581
11	<i>Calytrix cravenii</i>	PERTH 01750348
12	<i>Calytrix cravenii</i>	PERTH 02157004
13	<i>Calytrix cravenii</i>	PERTH 02157063
14	<i>Calytrix cravenii</i>	PERTH 02157179
15	<i>Calytrix cravenii</i>	PERTH 02157187
16	<i>Calytrix cravenii</i>	PERTH 02157225
17	<i>Calytrix cravenii</i>	PERTH 02157268
18	<i>Calytrix cravenii</i>	PERTH 02157403
19	<i>Calytrix cravenii</i>	PERTH 02157411
20	<i>Calytrix cravenii</i>	PERTH 02157438
21	<i>Calytrix cravenii</i>	PERTH 02157446
22	<i>Calytrix cravenii</i>	PERTH 02157454
23	<i>Calytrix cravenii</i>	PERTH 02157497
24	<i>Calytrix cravenii</i>	PERTH 02157500
25	<i>Calytrix cravenii</i>	PERTH 02157519
26	<i>Calytrix cravenii</i>	PERTH 02157624
27	<i>Calytrix cravenii</i>	PERTH 03118630
28	<i>Calytrix cravenii</i>	PERTH 03174786
29	<i>Calytrix cravenii</i>	PERTH 04426797
30	<i>Calytrix cravenii</i>	PERTH 04669258
31	<i>Calytrix cravenii</i>	PERTH 04936434
32	<i>Calytrix cravenii</i>	PERTH 05027667
33	<i>Calytrix cravenii</i>	PERTH 05120217
34	<i>Calytrix cravenii</i>	PERTH 05205050
35	<i>Calytrix cravenii</i>	PERTH 05505771

Table 1. cont.

Number	Taxa	Voucher
36	<i>Calytrix cravenii</i>	PERTH 05997895
37	<i>Calytrix cravenii</i>	PERTH 06331297
38	<i>Calytrix cravenii</i>	PERTH 06742351
39	<i>Calytrix cravenii</i>	PERTH 06828701
40	<i>Calytrix cravenii</i>	PERTH 07197179
41	<i>Calytrix cravenii</i>	PERTH 07213751
42	<i>Calytrix cravenii</i>	PERTH 07779577
43	<i>Calytrix cravenii</i>	PERTH 07811705
44	<i>Calytrix cravenii</i>	PERTH 07868642
45	<i>Calytrix cravenii</i>	PERTH 07868707
46	<i>Calytrix cravenii</i>	PERTH 08076030

Table 2. Morphological comparison of measured quantitative characters between *Calytrix cravenii*, *C. calingiri*, and the Collie specimen discussed in the text.

Character	<i>C. cravenii</i>	Calingiri form	Collie specimen
Leaf length (mm)	4.4–10.5	2.6–3.9	4.7
Leaf length:width ratio	9.5–26.0	5–8.5	6.6
Hypanthium length (mm)	2.8–5.0	2.1–2.9	2.4
Hypanthium: bracteole length ratio	0.97–1.8	0.7–0.9	0.9
Petal length (mm)	3.8–7.8	3.8–5	4.2
Style length (mm)	2.4–6.5	2.6–4.6	3.7
Inflorescence length (mm)	30–125	20–50	n/a

Key to species of the *Calytrix acutifolia* species group

1. Bracteoles with translucent wings that extend to and overlap to the apex, covering $> 3/4$ the length of the hypanthium; corolla 7.5–10 mm long; leaf blades 0.6–1.1 mm wide, with a distinct, protruding adaxial midrib, depressed-triangular in T.S. with a concave adaxial surface (Lesmurdie–Oakley)..... **C. acutifolia**
- 1: Bracteoles with translucent wings reduced, the hypanthium clearly visible, or with translucent wings that extend and overlap for $< 1/2$ the length of the hypanthium; corolla < 7 mm long; leaf blades < 0.6 mm wide, lacking a protruding adaxial midrib, depressed-triangular to obovate in TS..... **2**
2. Leaf blades obtriangular to depressed-obtriangular in TS, glabrous to prominently ciliate on margins, the hairs 0.05–0.2 mm long; stems with hairs 0.05–0.15(–0.2) mm long (Dongara–Narrogin)..... **3**
- 2: Leaf blades depressed angular-obovate in TS, glabrous to sparsely ciliate on margins, the hairs to 0.05 mm long; stems with hairs 0.2–0.5 mm long **4**
3. Bracteoles and sepals longer than the hypanthium, which is 2.1–2.9 mm long; mature inflorescences 20–50 mm long; leaf blades 2.6–3.9 mm long; leaf length:width ratio 5–8.5; plants single-stemmed at base, at least when young (Calingiri area)..... **C. calingiri**
- 3: Bracteoles and sepals usually shorter than the hypanthium, which is 2.8–5.0 mm long; mature inflorescences (30–)50–125 mm long; leaf blades 4.4–10.5 mm long; leaf length:width ratio 9.5–26.0; plants abundantly multi-stemmed at base, at least when mature (Dongara–Narrogin) **C. cravenii**
4. Hypanthium (2–)2.5–3.5 mm long, mostly 6–8-ribbed, smooth to somewhat rugose between the ribs; leaves patent at maturity (Yallingup–Esperance)..... **C. hirta**
- 4: Hypanthium 1.5–2 mm long, 5-ribbed, markedly rugose between the ribs; leaves reflexed at maturity (Busselton–Tutunup)..... **C. retrorsifolia**

Taxonomy

Calytrix cravenii Nge & K.R.Thiele, *Nuytsia* 28: 330 (2017).

Lhotskya scabra Turcz., *Bull. Soc. Imp. Naturalistes Moscou* II. 324 (1862). *Type*: ‘Nova Hollandia. Gilbert n. 186.’ (*lecto*: KW 1001262 image!, inadvertently designated by L. Craven, *Austral. Syst. Bot.* 10: 122 (1987); *isolecto*: K 821950 image!).

Calytrix sp. Eneabba (B.J.Lepschi & T.R.Lally BJL3617), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 14 December 2016].

Calytrix sp. Wheatbelt (R. Davis 4544), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 14 December 2016].

Erect, open *shrubs* 0.5–2 m high, multi-stemmed at base and presumably resprouting after fire. *Young stems* abundantly pilose with hairs 0.05–0.15(–0.2) mm long, mottled cream and pale brown or red-brown on new growth, with prominent leaf scars on older stems. *Leaves* alternate to partially subopposite; foliar colleters absent; petioles 0.5–1 mm long, yellow, glabrous to ciliate; blades linear to linear-oblongate, (4.4–)6–8(–10.5) mm long, 0.35–0.58(–0.73) mm wide, depressed-triangular in TS, glabrous to prominently ciliate with hairs 0.05–0.2 mm long; oil glands usually absent, sometimes noticeable; apex acute to obtuse. *Inflorescences* (30–)50–125 mm long, extending to 2–10

mm below shoot apex at anthesis; peduncles 0.5–0.8 mm long; bracteoles green to light brown, ciliate along midrib, (2.3–)2.8–3.5(–4) mm long, free or slightly connate at base, with entire margins, long-acuminate apex, and translucent wings reduced and scarcely overlapping. *Flowers* 5-merous, *c.* 10–15 mm diam.; hypanthium 5-ribbed, subcylindrical, 2.8–5 mm long, usually longer than the bracts and exposed above them, smooth or rugose-pitted between the ribs, glabrous to finely ciliate, with two rows of hairs along each rib; sepals 0.6–1.1 mm long, 0.4–0.8 mm wide, glabrous, the margin erose, the apex obtuse-truncate, lacking awns; petals (3.8–)5–6.5(–7.8) mm long, (1–)1.5–1.7 mm wide, white (pale yellow in bud), glabrous; staminodes absent; stamens 18–29, white, 2-seriate, the longest filaments 4–5 mm long, the anthers 0.2–0.3 mm long; style (2.4–)5(–6.5) mm long, white. *Seeds* not seen. (Figure 2A, 3E–G)

Selected specimens examined. WESTERN AUSTRALIA: Site Gch 1, 10 km SW of Goomalling on Goomalling–Toodyay Road, 24 Oct. 1993, *P. Armstrong s.n.* (PERTH); private property, 11 km S of Pingelly, E side of railway, 28 Oct. 1995, *D. Box* PGY DB143 (PERTH); north side of Robinson Road – just W of Arrowsmith River Crossing, *c.* 42 km S of Mingenew, 8 Oct. 1992, *A. Carr* 131 (PERTH); 9.5 miles from Three Springs on Eneabba road, 15 Oct. 1978, *C. Chapman* (18)78 (PERTH); 6 km SE of Kweda, 21 Oct. 1983, *R.J. Cranfield* 4518 (PERTH); 8 km S of Marchagee and 8 km along the road off to the west, 28 Oct. 1981, *L.A. Craven* 7310 (PERTH); Popanyinning, between town and rail crossing S of town, 8 Nov. 1981, *L.A. Craven* 7436 (PERTH); Barberton West Road, SW of Moora, 28 Sep. 2007, *A. Crawford* ADC 1348; Duranillin–Bowelling Road, 1 km W of Duranillin, 18 Nov. 1997, *R. Davis* 4544 (PERTH); road verge – introduced, Collie area, May 1972, *L. Dodd* (A) (PERTH); Great Southern Highway, 2.6 km SE of Hotham River crossing, 4.3 km due N of Popanyinning, 23 Nov. 1988, *J.M. Fox* 88/332 (PERTH); Boothendarra Hill Reserve (29719), N of Badgingarra AMG 50JLM613503 (Badgingarra 1:50,000 sheet), 24 Sep. 1988, *E.A. Griffin* 5253 (PERTH); Boonanarring Nature Reserve, Gingin, on the western boundary *c.* 1.45 km S of Wannamal West Road, 27 Oct. 2001, *F. Hort, J. Hort, B. & B. Backhouse* 1577 (PERTH); W side of the Wongan Hills, *c.* 200 km NE of Perth, 29 Oct. 1980, *K.F. Kenneally* 7511 (PERTH); Mortlock River crossing on Bolgart East Road, *c.* 3 km ENE of Smith Road turnoff, *c.* 8.5 km NW of Goomalling, 21 Oct. 1997, *B.J. Lepschi*



Figure 2. A – *Calytrix cravenii* (F. Nge 610); B – *C. calingiri* (F. Nge 619). Photographs by F. Nge.

& T.R. Lally 3617 (PERTH); spring-fed creek 30 km NE of Eneabba on edge of unnamed NR A12705, E side of Skipper Road 4 km NNE of intersection of Bunney Road and Skipper Road. SAP wetlands site SPS180B, 23 Sep. 1999, M.N. Lyons & S.D. Lyons 3534 (PERTH); Jingaring Nature Reserve, Jingaring road, c. 30 km ENE of Pingelly, 7 Nov. 1999, L.W. Sage, R. Davis & F. Obbens LWS 1328 (PERTH); 43 km S of the Brand Highway and Midlands Highway junction, S Dongara, 14 Nov. 2008, L.S.J. Sweedman 7587 (PERTH); wasteland along Hotham River near where it crosses Brookton Highway [the Hotham River crosses the Great Southern Highway near Carraching], 10 Nov. 2002, G. Warren & P. Rose 686 (PERTH).

Phenology. Flowers in spring to early summer, from September to December, with a peak from mid-October to November.

Distribution and habitat. Wide-ranging, found in a range of habitats in the Geraldton Sandplains and Avon Wheatbelt bioregions, from Dongara to Wongan Hills, south to Narrogin (Figure 4), commonly on white, grey, or yellow sandplains with associated kwongan heath or low woodland vegetation communities. A few populations are found near riverbanks and valleys, on dry white sand or damp sandy clay along drainage lines.

Conservation status. Not considered to be at risk; widespread throughout its range although many populations are found on road verges where little native vegetation remains.

Notes. *Calytrix cravenii* flowers later than *C. calingiri*, with a peak in November compared to *C. calingiri* which mainly flowers in spring (peak in September). A noticeable difference in the field between *C. cravenii* and *C. calingiri* is their growth habit, with *C. cravenii* abundantly suckering from the rootstock (as in other members of the *C. acutifolia* complex) while *C. calingiri* plants are single-stemmed at the base and ‘tree-like’ when young (Figure 3). The suckering shrub habit of *C. cravenii* suggests that this species likely resprouts after fire, but this has not been directly observed.

Calytrix calingiri Nge & K.R.Thiele, *sp. nov.*

Type: Calingiri, Western Australia [precise locality withheld for conservation reasons], 21 September 2019, F.J. Nge & K.R. Thiele 1080 (*holo:* PERTH 09446249; *iso:* AD, CANB, K, MEL, NY).

Erect, open *shrubs* 0.5–2 m high. *Young stems* pilose with hairs 0.05–0.1 mm long, mottled cream and pale brown or red-brown on new growth, with prominent leaf scars on older stems. *Leaves* alternate to partially subopposite; foliar colleters absent; petioles 0.4–0.7 mm long, yellow, glabrous to ciliate; blades linear to linear-oblongate, 3–11 mm long, 0.3–0.9 mm wide, depressed-triangular in T.S., glabrous to prominently ciliate with hairs c. 0.1 mm long; oil glands usually absent, sometimes noticeable; apex acute to obtuse. *Inflorescences* 20–50 mm long, extending to 2–10 mm below shoot apex at anthesis; peduncles 0.1–0.3 mm long; bracteoles green to light brown, ciliate along midrib, 2–3.2 mm long, free to slightly connate at base, with entire margins and long-acuminate apex, the translucent wings reduced and scarcely overlapping. *Flowers* 5-merous, c. 8.5–10(–11) mm diam.; hypanthium 5-ribbed, subcylindrical, 2–2.9 mm long, usually shorter than and covered by the bracts, smooth or rugose-pitted between the ribs, glabrous to finely ciliate, with two rows of hairs along each rib; sepals 0.25–0.5 mm long, c. 0.5 mm wide, glabrous, the margin erose, the apex obtuse-truncate, lacking awns; petals 3.8–4.5(–5) mm long, 0.8–1.3 mm wide, white (pale yellow in bud), glabrous; staminodes absent; stamens 18–29, white, 2-seriate, the longest filaments 4–4.6 mm long, the anthers 0.2–0.3 mm long; style 2.6–4.6 mm long, white. *Seeds* not seen. (Figure 2B, 3A–D)

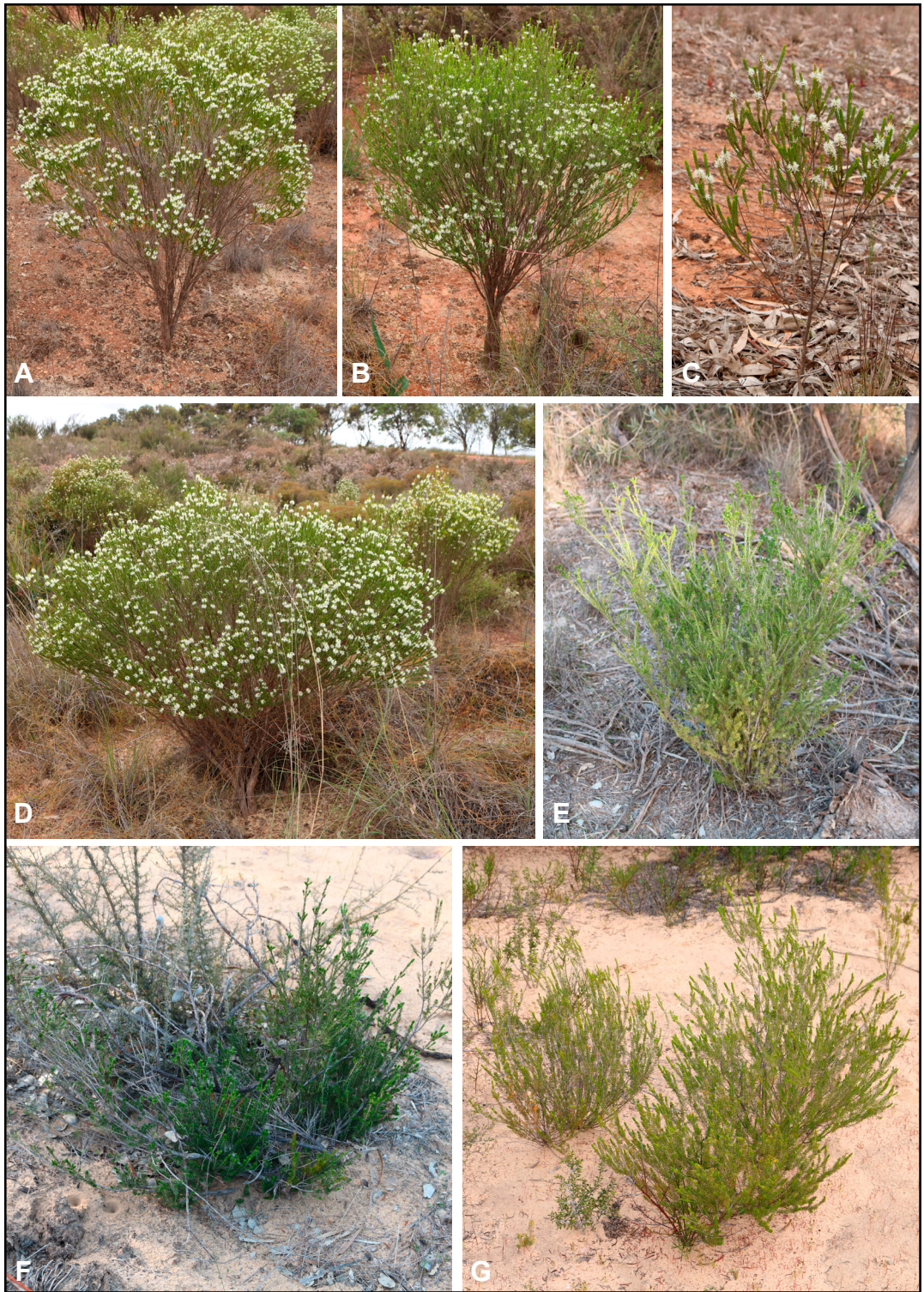


Figure 3. Growth forms of *Calytrix* spp. A–D *Calytrix calingiri* (F. Nge 619) – compact single-stemmed tree of all ages (young–mature); E–G *C. cravenii* – spreading shrub (E–F: F. Nge 1049; G: F. Nge 610). Photographs by F. Nge.

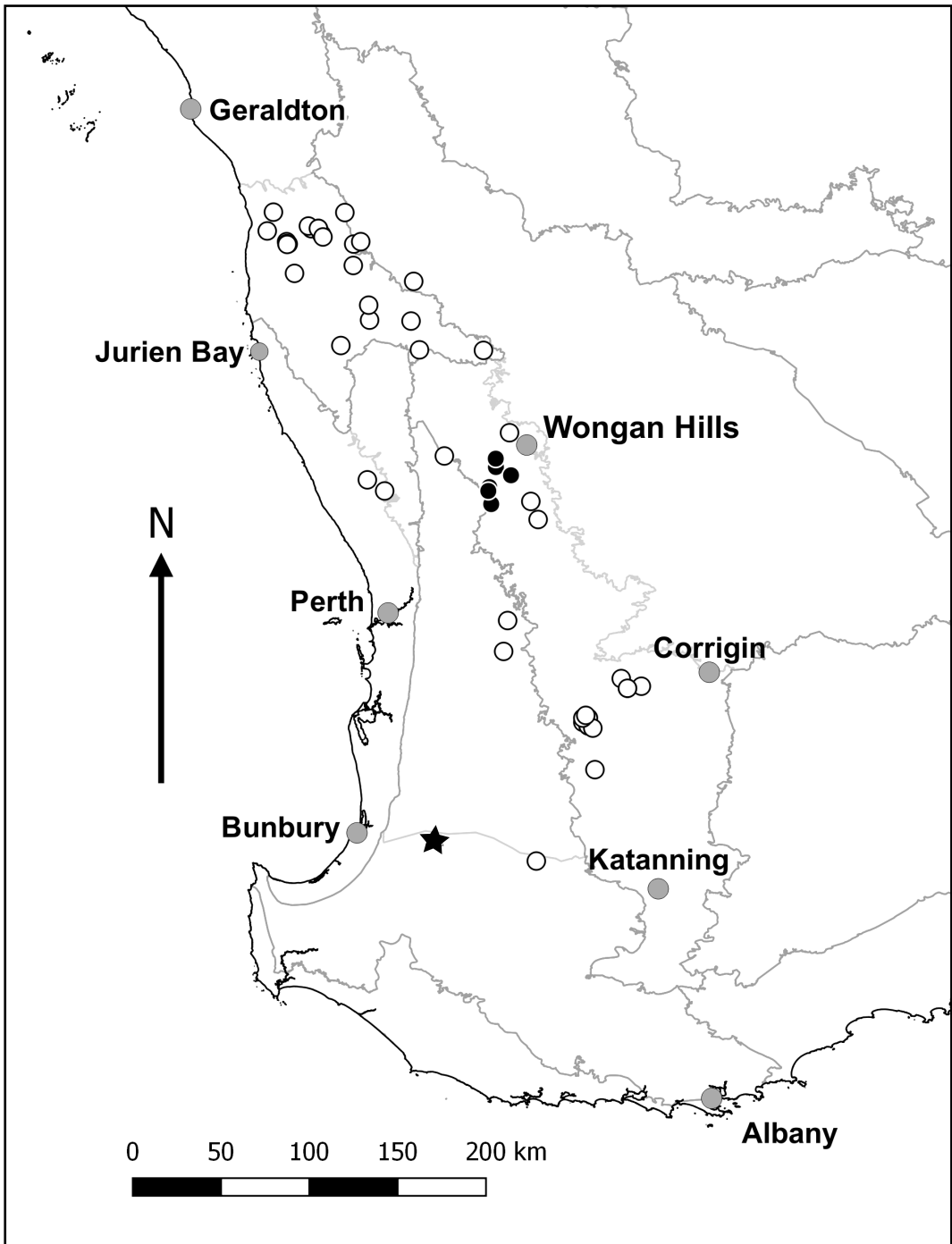


Figure 4. Distribution of *Calytrix calingiri* (●), *C. cravenii* (○), and *C. 'Collie'* (★) in south-west Western Australia.

Diagnostic features. *Calytrix calingiri* is smaller in floral and leaf characters than *C. cravenii*. The following combination of characters can be used to differentiate *C. calingiri* from *C. cravenii*: bracteoles and sepals covering the hypanthium (i.e. hypanthium:bracteole length ratio < 1, usually 0.7–0.9); hypanthium 2.1–2.9 mm long; petals 3.8–4.5 mm long; mature inflorescence 20–50 mm long; leaf blades 2.6–3.9 mm long; leaf length:width ratio 5–8.5.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 30 Aug. 1971, *T.E.H. Aplin* 4881 (PERTH); Aug. 1938, *Erickson s.n.* (PERTH); 6 Aug 2005, *F. Hort & J. Hort* FH 2568 (PERTH); 21 Sep. 2019, *F.J. Nge & K.R. Thiele* 1081 (PERTH); 6 Oct. 2018, *F. Nge & L.J.R. Shelton* 619 (AD); 6 Oct. 2018, *F. Nge & L.J.R. Shelton* 623 (AD 284797); 10 Sep. 1974, *Powell* 74087 (PERTH); 22 Sep. 1955, *Royce* 5151 (PERTH); 9 Dec. 2018, *K.R. Thiele* 4006 (PERTH).

Phenology. Flowers in late winter to spring, from August–October, with a peak in September.

Distribution and habitat. *Calytrix calingiri* has a localised distribution around Calingiri (Figure 4), where it is associated with kwongan and wandoo woodlands on dry white sand or sandy loam. Its distribution falls within that of *C. cravenii*, with the shortest distance between populations of the two species c. 20 km. There is no indication that nearby populations of *C. cravenii* are more similar to *C. calingiri* than they are to more distant ones.

An outlying specimen from the Collie area (*L. Dodd s.n.* PERTH 02157195) may have been introduced with road materials, as it is well to the west of the main distribution and is the only collection known to occur in the Jarrah Forest bioregion.

Conservation status. Restricted in range, currently only known to occur in one Nature Reserve; many populations are found along road verges. To be listed as Priority Three under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.).

Etymology. From the place-name Calingiri, used as a noun in apposition.

Notes. See notes under *C. cravenii*.

Acknowledgements

We thank the Curator and staff of the Western Australian Herbarium for access to specimens and facilities. We also thank Lindsay Shelton for assistance and company during our field visits to populations of *C. calingiri*. Fieldwork to collect voucher specimens and DNA material was supported by the South Australian Department of Environment, Water and Natural Resources (grant D0004335204).

References

- Nge, F.J., Biffin, E., Waycott, M. & Thiele, K.R. (2021). Phylogenomics and continental biogeographic disjunctions: insight from the Australian starflowers (*Calytrix*). *American Journal of Botany* 109: 291–308.
- Nge, F.J., Keighery, G.J. & Thiele, K.R. (2017). A revision of the *Calytrix acutifolia* complex (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 321–337.
- R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.r-project.org/>

