



## *Goodenia asteriscus* (Goodeniaceae), a new arid zone species from north-western South Australia and eastern Western Australia

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**Abstract:** *Goodenia asteriscus* P.J.Lang, a perennial, facultatively stoloniferous, rosette-forming herb is described, illustrated and mapped, with distinguishing features and affinities also discussed. While this species belongs to a group characterised by unequal wings on the adaxial corolla lobes, it does not closely resemble any other species. An amendment to the *Flora of Australia* key is provided.

**Keywords:** biodiversity, new species, taxonomy, Australia, *Goodenia* subsect. *Goodenia*

### Introduction

In May 2011, the second author collected a potentially new *Goodenia* species while employed by Outback Ecology Services to undertake an environmental assessment survey of the proposed Southern Borefield for the Metal-X Wingellina Nickel Project in far eastern Western Australia (WA), c. 100 km SW of Irrunytju (Wingellina) in the Ngaanyatjarra Aboriginal Lands. Davies (2011) noted its affinity to *Goodenia heteromera* F.Muell., a species not recorded from WA, but recognised it as different. He sent the collection (R.J.-P.Davies & L.Ransom LR868) to PERTH where it was examined by M. Hislop, who could not place it satisfactorily with any currently recognised species of *Goodenia* in WA. Hislop (pers. comm., 2011) confirmed the apparent affinity to *G. heteromera*, noting a similarly-shaped indusium, but pointed out that there were no signs of stolons on the specimen and that it had significantly larger seeds with much wider wings outside the range given for that species by Carolin (1992, p. 235). He suggested that it be referred to as *Goodenia* sp. aff. *quasilibera* (Davies & Alford 2012).

In November 2011 a further six collections were made by RJPD along a proposed access track for the borefield (Davies & Chapman 2011). These were referred to PJJ whose investigations of this and other material resulted in the description and account presented here.

Matching specimens assembled by M. Hislop and loaned from PERTH showed that the taxon had been collected twice elsewhere in WA. The first known collection was made in 1963 (*A.S. George 4809*) and the second in 1973 (*D.E.Symon 8437*). Neither had been identified to species, but an AD duplicate of the latter

had been identified as *Goodenia fascicularis* F.Muell. & Tate by R.C. Carolin in 1976.

A review of AD collections was made to see if it was also present in South Australia (SA), focussing on unidentified material and species of similar appearance from the adjoining North-western Region (NW). This uncovered four collections, all of which had been misidentified as *G. fascicularis*.

In 2016, a short visit to the Anangu Pitjantjatjara Yankunytjatjara Lands in the NW of SA by PJJ enabled additional field observations and collections for this paper, including the type.

### *Goodenia asteriscus* P.J.Lang, sp. nov.

**Type:** P.J.Lang 2928 & C.J.Brodie, 11 Oct. 2016, 12.1 km NW Kunytjanu homeland, 48.3 km SSE from Pipalyatjara on road to Watarru, 26°35'11"S 129°16'55"E, North-western Region, South Australia (holo.: AD 278175; iso.: CANB, DNA, K, PERTH).

*Goodenia* sp. aff. *quasilibera* (L. Ransom 868) R.J.Davies & J.Alford, *Metals X Ltd Wingellina Nickel Proj. Level 1 Fl. & Veg. Assessment Wingellina Borefield Apr. 2012* (2012).

*Goodenia fascicularis* auct. non F.Muell. & Tate: Symon in W.R.Barker et al., *J. Adelaide Bot. Gard. Suppl.* 1: 133 (2005), partly.

Perennial, facultatively stoloniferous, rosette-forming herb 8–22 cm high, developing a woody taproot and thickened basal stem retaining old pedicel bases; vegetative parts strigose to sericeous, predominantly clothed in simple hairs that are antrorse, lightly to strongly appressed, laterally basifixed, straight to gently and irregularly curved, moderately thick and stiff, whitish (to pale gold) and translucent, sometimes

also with some obscure sparse minute short glandular hairs, and spreading, long, thin, irregular, white, septate, cottony hairs in and approaching axils and occasionally extending sparsely to lower parts of leaves. *Leaves* in dense basal rosettes, sometimes also terminal on flowering racemes transitioning to form secondary rosettes, procumbent to inclined adaxially, spatulate or (narrowly-) obovate to oblanceolate-elliptic, (15–) 25–65 × 5–18 mm (including petiole), all entire or earlier leaves entire and later ones dentate to pinnatifid and sometimes pinnatisect basally, with mid-dense antrorse simple hairs and obscure sparse small glandular hairs or the latter absent; lamina gradually tapering to an indistinct petiole, 10–35 mm long; margins with 0–8 lobes, each 1–9 × 1–3.5 mm; apex acute; stolons 40–75 (–100) mm long or absent. *Inflorescences* radiating from base of rosette, with 0–19 single-flowered ebracteolate scapes (20–) 30–90 (–110) mm long, stiff when mature, (usually) straight and persisting long after flowers or fruit have fallen, and 0–21 erect to decumbent 2–5 (–8) -flowered, ebracteolate racemes (30–) 60–140 mm long; bracts leaf-like, (narrowly) oblanceolate, 10–25 × 1.5–5 mm, entire, with acute apex, all (excepting sometimes the lowest) subtending pedicels; racemes

often contracted distally and grading to stolons bearing terminal rosettes; scapes, raceme axes, and pedicels with antrorse ± appressed simple hairs only, denser and more spreading at articulation with ovary. *Sepals* (narrowly) lanceolate to very narrowly elliptic 3.5–6 × 1–1.4 mm, their basal 1/3 adnate to lower 1/2 – 2/3 of the ovary, outside with mid-dense antrorse, appressed, strigose, simple hairs and sparse short glandular hairs, inside glabrous. *Corolla* predominantly yellow, deeper towards the throat and paler on wings, grading to grey-violet with darker anastomosing venation on lower adaxial lobes and base of abaxial lobes to dark violet inside throat, 12.5–18 mm long, all of outside with dense indumentum of short glandular hairs, strigose hairs sparse, confined to lobe apices, or absent; tube 1.6–3 mm long to dorsal sinus of adaxial lobes, with pouch moderately developed and extending 1–1.5 mm below sepal lobe attachment but 0.5–0.8 mm short of ovary base; without enations, erect short simple hairs on much of inside of tube and throat and extending forwards along lateral margins of a raised, thickened yellow zone below the median lobe; auricles exceeding indusium, overlapping each other and obscuring indusium in flower; corolla lobes often decurved. *Abaxial corolla lobes* (3.5–) 4.5–8 (–9.3) × 1.5–2.3 mm, fused for 5–8 mm beyond junction with adaxial lobes, apex acute; wings along terminal 2.5–6.5 mm of lobes, 3.5–7.5 (–9) mm × 1.3–3.2 mm, projecting 0.8–2.5 mm beyond lobe apex, with entire margins. *Adaxial*



**Fig. 1.** *Goodenia asteriscus*, 92 km SW of Wingellina, WA, on 21 Nov. 2011 (R.J.Davies 464). **A** Old plant with a woody base, persistent radiating scapes and entire leaves; **B** closer view of flowers.



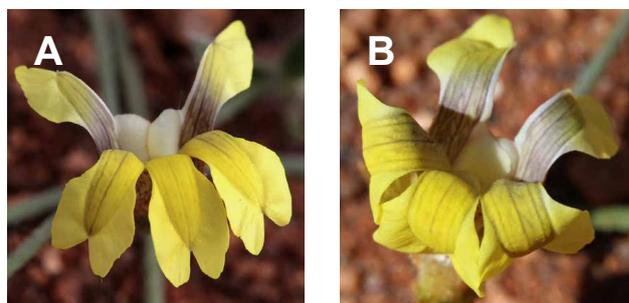
**Fig. 2.** *Goodenia asteriscus*, c. 12 km NW Kunyntjanu homeland, SA, on 11 Oct. 2016. **A** Decumbent plant with lobed leaves (P.J.Lang 2928 & C.J.Brodie, Holotype); **B** young plant with prostrate inflorescences in early stage of transition to stolons (P.J.Lang 2926 & C.J.Brodie).

*corolla lobes* 7–11.5 × 1–1.9 mm, fused to throat for a further 1–3.5 mm to their divergence at dorsal sinus; auricle yellowish-white, cuneate-cymbiform, 3.2–5.5 × 1.5–2.1 mm, with a fringe of hairs 0.2–5 mm long along its junction with lobe; wings unequal, above the auricle vestigial and 0.15–0.4 (–0.8) mm wide, on opposite side along terminal 2.3–4.2 mm of lobe, 3–7 × 1–2.5 mm, with entire margins. *Stamen* filaments linear, dorsiventrally flattened, 2.5–4 mm long, anthers (narrowly) oblong 1.6–2.4 × 0.4–1 mm, base auriculate. *Ovary* 3–4.8 × 1.9–2.8 mm, narrowly obovate, tapering basally into a short stalk for 0.3–1.5 mm above articulation with pedicel; septum incomplete,  $\frac{2}{3}$  length of locules, glabrous; ovules 38–48. *Style* straight, 3.3–4.5 × 0.8–1.0 mm, expanding to 1.8 mm at junction with indusium, with spreading fine soft simple hairs 0.2–0.3 mm long, denser on underside and forming a beard at indusium junction. *Indusium* light brown, convex above, dorsi-ventrally compressed, obverse-trapeziform, slightly wider than long, 1.5–2.2 × 1.6–2.6 mm, glabrous on back, apical margin straight on dorsal side, retuse on ventral side, orifice narrow, bristles dense, white, flexed upwards on dorsal lip, reflexed on ventral lip, grading in length from 0.2 mm at margins to 0.7 mm at centre. Fruit (widely-) ellipsoid, 7–10 × 5–7 mm. Seeds (3.5–) 4–6.2 × (3–) 3.5–5.2 mm, not mucilaginous; seed body brown, flat to lightly convex, broadly lacrimiform-obovate, seed coat shallowly reticulate; wing (0.7–) 1–1.9 mm wide, pale-brown to stramineous, continuous with seed body. **Figs 1–6.**

**Affinities and distinctive features.** *Goodenia asteriscus* belongs in *Goodenia* sect. *Goodenia* subsect. *Ebracteolatae* K.Krause, based on its yellow corolla, prominent seed wing and the absence of bracteoles. Within this subsection it fits Group 8 in the *Flora of Australia* key of Carolin (1992) defined by “Flowers not bracteolate; corolla wings unequal on [adaxial]<sup>1</sup> lobes”. It is a distinctive species that does not closely resemble any other.

*Goodenia asteriscus* is most like *G. heteromera* and *G. pascua* Carolin in the very strong differentiation of the adaxial (or posterior) corolla lobes, and with these two species also shares a convex brownish indusium with reflexed white bristles, articulate pedicels, and reticulate seeds with prominent wings. *Goodenia pascua* is readily distinguished by its well-developed long racemes, the absence of pedicels arising directly from the rosette, and its smaller flowers (6–10 mm long) with the outside of the corolla covered in strigose hairs. The corolla of *G. pascua* has a distinctive brown throat, and the corolla of *G. asteriscus* most closely resembles that of *G. heteromera* where the adaxial lobes differ from the abaxial ones, not only by their markedly unequal wings (very narrow or vestigial on the side above the auricle), but also by having purple-violet coloration and dark veining extend further up from the base of the lobes

towards the apex<sup>2</sup> (Figs 6 & 7). However, compared to *G. heteromera*, *G. asteriscus* has larger flowers 12.5–18 mm long (vs. 6–11 mm), with a well-defined corolla pouch (vs. weakly or not developed); larger auricles much exceeding the indusium (vs. similar in length to indusium), but with much shorter fringing hairs; and larger seeds 3.5–5.2 mm diam. (vs. 1.5–2.5 mm) with a proportionately wider and more confluent wing (vs. edge of seed body bevelled near wing junction). Also, the indusium differs in detail, being broader and dorsiventrally compressed with a thin orifice (cf. more elongate and barrel-shaped with a gaping orifice in *G. heteromera*). A distinctive feature is the marked gradation in bristle length across the indusium orifice (cf. gradation weak or not apparent in *G. heteromera*) (Figs 6 & 7).



**Fig. 3.** *Goodenia asteriscus*, flowers. **A** P.J.Lang 2928 & C.J.Brodie (Holotype); **B** P.J.Lang 2926 & C.J.Brodie.



**Fig. 4.** *Goodenia asteriscus* (D.E.Symon 8437). **A** Mature fruit; **B** dissepiment.



**Fig. 5.** *Goodenia asteriscus*, seeds (R.J.Davies 461).

<sup>1</sup> in error as “abaxial” as noted by Sage (2000, p. 375)

<sup>2</sup> This difference is sometimes obscured on pressed specimens as the darker coloration becomes stronger and more extensive on drying.



**Fig. 6. *Goodenia asteriscus*** (P.J.Lang BS23-25475). **A** Pressed flower, showing auricles much exceeding the indusium, and markedly unequal adaxial lobe wings; **B** closer view of different flower, showing indusium with gradation in length of bristles at orifice.



**Fig. 7. *Goodenia heteromera***. **A** Pressed flower, showing adaxial corolla lobes with unequal wings (P.J.Lang 2275); **B** closer view, showing indusium with orifice bristles of  $\pm$  even length and the relatively small auricles (D.J.Duval 2298).



**Fig. 8. *Goodenia elongata***. **A** Pressed flower, showing adaxial corolla lobes with equal wings and elongate auricle exceeding the indusium, which has its left side partly folded under (M.Fagg 354); **B** closer view, showing transversely oblong indusium with orifice bristles of  $\pm$  even length and dorsal hairs; glandular hairs on outside of corolla visible on lower left adaxial lobe (R.Bates 6675).

Recent DNA sequencing (Shepherd *et al.*, in prep.) places *G. asteriscus* (represented by *R.J.-P.Davies & L.Ransom LR868*) as sister to *G. elongata* Labill., before linking to clades with *G. heteromera* and *G. pascua*. In *G. elongata* the adaxial corolla lobes are relatively undifferentiated with their wings either equal (in most specimens observed) (Fig. 8A) or only a little narrower above the auricles. This species also shares the broadly similar indusium, articulate pedicels, and reticulate, prominently winged seeds, but in addition matches *G. asteriscus* by its glandular hairs on the outside of the corolla (although varying from mid-dense to sparse) (Fig. 8B), large elongate auricles, and large flowers.

*Goodenia elongata* is a species of damp habitats confined to south-eastern Australia. In addition to the equal to sub-equal adaxial corolla wings, it is readily distinguished from *G. asteriscus* by its rhizomatous and erect habit with well-developed cauline leaves and weak rosette formation (vs. facultatively stoloniferous rosettes), variable indumentum of stems and leaves ranging from glabrous to mid-dense and sub-appressed to strongly spreading (vs. mostly mid-dense and lightly to strongly appressed), and a transversely oblong indusium more than twice as wide as long (vs. slightly wider than long) bearing simple hairs on its back (vs. glabrous) and shorter orifice bristles of uniform length (Fig. 8B) (vs. grading to longer in the centre).

Stolon production in *G. asteriscus* is much less strongly developed than in *G. heteromera*, a trait which enables that species to rapidly colonise wet clay soils in its flood plain habitats subject to temporary inundation. Fully differentiated stolons were seen in only a few collections of *G. asteriscus* (e.g. *D.E.Symon 8437*, *P.J.Lang 2959 & C.J.Brodie*), while some others had intermediate states in transition from racemes. Furthermore, individual plants varied widely in the proportion of racemes to single-flowered scapes arising from the main rosette. Counts of racemes vs. scapes ranged from 10:1 and 17:3 at one extreme through to 1:5 and 0:25 at the other. Variation in the ratios of these inflorescence types was independent of rosette size, and together with occasional development of stolons from racemes is indicative of different growth phases, possibly determined by conditions in the immediate environment.

The particularly large auricles (Fig. 6), also present in *G. elongata*, are a notable feature of *G. asteriscus*. In all fresh flowers of *G. asteriscus* observed, they overlapped each other and completely obscured the indusium (Figs 1B & 3), similar to the effect noted and illustrated by Holland (2015, p. 64, fig. 2) for *G. effusa* A.E.Holland. Holland (2012, p. 690) found enclosing of the indusium by the auricles in *G. minutiflora* F.Muell. to be variable and suggested that this might be due to flowering stage or an artefact of pressing. However, field observations of *G. asteriscus* showed it to be consistent during flowering. In *G. heteromera* the auricles are only large enough to partly cover the indusium (Fig. 7B). Yeo (1993, p. 150) suggested that sheltering of the

indusium by the auricles was important in controlling access to pollen and favoured pollination by bees.

Although *G. quasilibera* Carolin is similar to *G. asteriscus* in having glandular hairs on the outside of the corolla, it differs significantly in other characters and analyses of both cpDNA markers and the nrDNA Internal Transcribed Spacer indicate that it is not closely related (Shepherd *et al.*, in prep). Other major differences include non-reduced adaxial lobe wings, a prominent corolla pouch or spur (often extending beyond the base of the ovary), the indusium with a concave margin at its orifice and glandular and simple hairs on its dorsal surface, and distinctive black seeds with a narrow overlapping wing.

*Goodenia fascicularis*, with which earlier collections were sometimes confused, is readily distinguished by the outside of its corolla lacking glandular hairs but covered in strigose hairs, a broader and less convex indusium with bristles uniform in length, and wings  $\pm$  equal in width on the adaxial corolla lobes.

The *Goodenia* key in *Flora of Australia* (Carolin 1992, p. 164) should be amended for Group 8 by replacing couplet 6 with the following:

**6. Plant stoloniferous**

**6a.** Corolla > 12 mm long, outside mainly covered by short glandular hairs . . . . . **G. asteriscus**

**6a:** Corolla < 11 mm long, outside mainly covered by simple strigose hairs . . . . . **G. heteromera**

**6: Plant not stoloniferous**

**6b.** Rosette-forming herb . . . . . **G. asteriscus**

**6b:** Herb or subshrub with erect leafy stems . . . . . **7**

**Distribution.** The known distribution of *G. asteriscus* spans 220 km from west of Cavenagh Range in WA to Mt Lindsay (Watarru) in the NW Region of SA, in areas that are not dominated by dense dunefields (Fig. 9). It is also reported for the Northern Territory, just across the border from SA, where P. Latz observed sterile plants matching those of *P.Latz 24770*.

**Ecology.** The species grows in hard clay and loam soils and is able to colonise compacted gravelly surfaces of road margins (*P.J.Lang 2926 & C.J.Brodie*) and an 'airway scrape' (*D.E.Symon 847*). It has been mostly found on limestone plains with outcropping calcrete or nodular limestone and associated plant communities dominated by *Triodia scariosa* hummock grassland, often with emergent *Eucalyptus socialis* subsp. *eucentrica* open mallee or *Acacia kempeana* open shrubland. The associated suite of plants recorded in the Wingellina Nickel project area (Davies 2011, Davies & Alford 2012), and those observed near Kunitjanu, closely fit floristic Group 22 'Spinifex Hummock Grassland on Limestone Plains' of Lang *et al.* (2003, p. 171), an extensive community in the Anangu Pitjantjatjara Yankunytjatjara Lands of South Australia.

A collection from NE slopes of a rocky hill known as 'Scarface' in the Tomkinson Ranges (J.Z. Weber 5397), is an exception to this habitat. It was confirmed by the discovery of a single plant (P.J. Lang 2959) on a rocky slope of the same range system composed of dark red-brown ultra-mafic rock.

**Flowering.** Mainly Sep.–Jan.

**Conservation status.** *Goodenia asteriscus* has been infrequently collected and the populations observed in the Wingellina borefield area (RJP) and NW of Kunytjanu (P.J.L.) amount to only a few hundred individuals in total. However, the widespread occurrence of its major habitat type, in terrain with limited road and track access, means that many more populations may exist. Until targeted surveys are undertaken, and in the absence of any discernable threatening processes, it is best assigned to the 'Data Deficient' category (IUCN 2017).

**Etymology.** The epithet, a Latin noun in apposition, is derived from the Greek *asteriskos* meaning 'little star'. It alludes generally to the radiating pattern of peduncles and secondary rosettes, but more particularly to the disposition of persistent flower scapes reminiscent of an asterisk symbol. A number of *Goodenia* species retain their scapes long after flowers or fruits have abscised, but this is a pronounced feature in *G. asteriscus*. Similar long, stiff, straight persistent radiating scapes are also seen in *G. pedicellata* L.W.Sage & K.W.Dixon (Sage & Dixon 2005, p. 515, fig. 1) and *G. gibbosa* Carolin (e.g. E.A. Shaw 450, 451) although these are not closely related.

#### ***Goodenia asteriscus* other specimens examined**

WESTERN AUSTRALIA: R.J. Davies 460 (-462, -464, -465, -466), 93 (-91, -92) km direct SW of Wingellina, c. 9 (-10.5) km direct W of Tjuntjuntjarra Track, on proposed access track route, (20–) 21 Nov. 2011 (AD); R.J.-P. Davies & L. Ransom LR868, Great Victoria Desert, c. 100 km SW of Wingellina township, towards southern end of proposed Southern Borefield for Metal-X Wingellina Nickel Project, 6 May 2011 (PERTH); A.S. George 4809, N end of Cavanagh [Cavanagh] Range, 8 Jul. 1963 (PERTH); M. Henson & M. Hannart 32638, 28 km SSE of Warburton [coordinates plot as: 113 km W of Warburton & 28 km S of Jameson Community], 29 Nov. 2011 (PERTH); D.E. Symon 8437, Blackstone Range, Wingellina [Wingellina], 8 Jan. 1973 (AD, PERTH; NSW *n.v.*).

SOUTH AUSTRALIA: **North-Western:** N.N. Donner 6458, up to c. 1 km SW of Krewinkel Hill, 2 Sep. 1978 (AD; G *n.v.*); P.J. Lang BS23-25475, 12.2 km NW of Kunytjanu Homeland on road to Pipalyatjara, 3.0 km direct WNW of Krewinkel Hill, 5 Sep. 1995 (AD, PERTH); P.J. Lang 2926, 2927, 2930 & C.J. Brodie, (12.1–) 12.2 km NW Kunytjanu homeland, 48.2 (-48.3) km direct SSE from Pipalyatjara, 12 Oct. 2016 (AD); P.J. Lang 2959 & C.J. Brodie, 0.85 km SW Kalka

community, on mid-slopes of Dulganina Hill range, 12 Oct. 2016 (AD); P. Latz 24770, 5 km NNW of Aparatjara, on track to Lake Wilson, 53 km E of Kalka, 3 Sep. 2009 (NT *n.v.*, image seen, AD *n.v.*, PERTH *n.v.*); D.E. Murfet BS23-27534, 14.5 km from Mt Lindsay NE towards Kintore Ave turn-off, 10.8 km direct NNE Wartaru [Watarru], 5 Sep. 1995 (AD); J.Z. Weber 5397, Tomkinson Ranges, Dulganina Hills, NE slopes of Scarface, c. 9 km direct NW of Mt Davies summit, 2 Sep. 1978 (AD; COLO *n.v.*).

#### ***Goodenia quasilibera* type specimens examined**

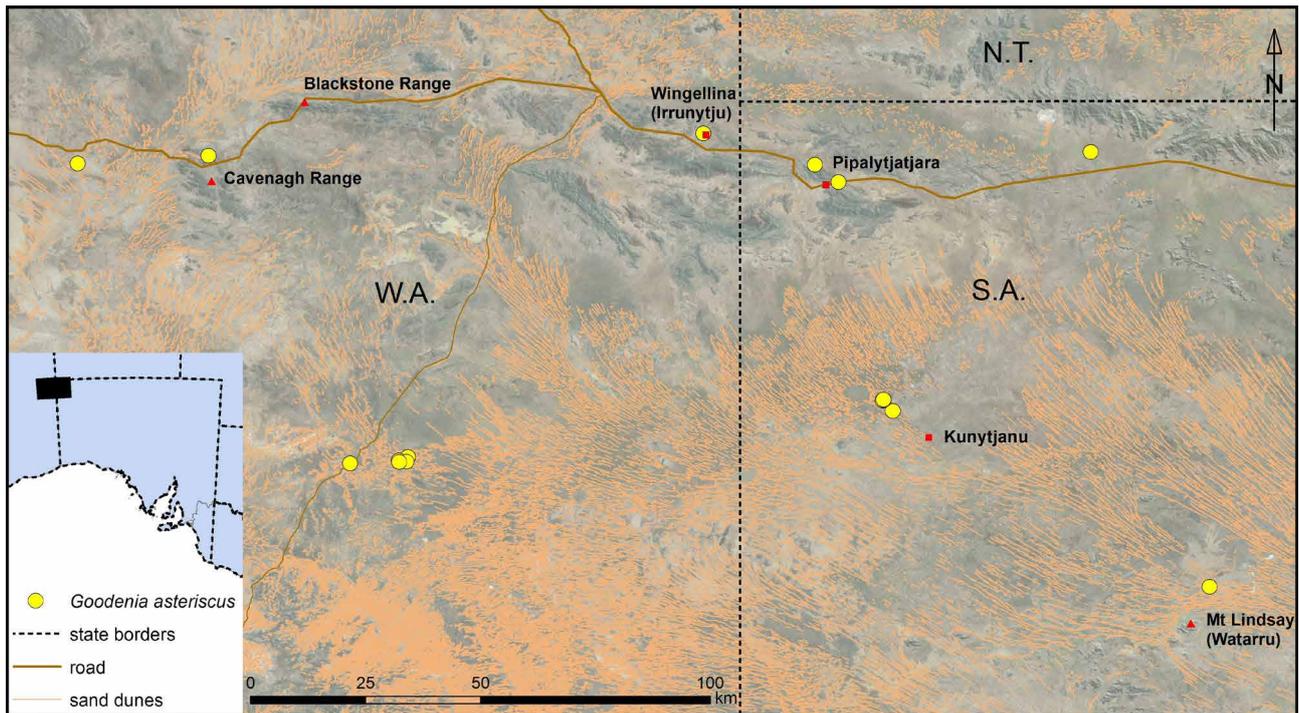
WESTERN AUSTRALIA: A.S. George 2171, Thomas River valley, N of Homestead, 10 Dec. 1960 (Holotype, PERTH).

### **Acknowledgments**

Support from Sara Weir and Anangu trainee rangers at Pipalyatjara in facilitating a revisit by P.J.L. of the population NW of Kunytjanu homeland, and from Chris Brodie for field assistance on that trip, was much appreciated. We are grateful for the initial investigation of WA collections by Mike Hislop, the loan of specimens from PERTH herbarium, and refinements to this paper suggested by Kelly Shepherd and Dave Albrecht.

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**Fig. 9.** *Goodenia asteriscus*, known distribution.

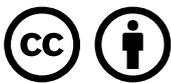
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