

Description of a new south-western Australian plant group, *Hypocalymma* sect. *Grandiflora* (Myrtaceae: Chamelaucieae: Astarteinae)

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Abstract

Rye, B.L., Keighery, G.J. & Barrett, M.D. Description of a new south-western Australian plant group, *Hypocalymma* sect. *Grandiflora* (Myrtaceae: Chamelaucieae: Astarteinae). *Nuytsia* 33: 233–249 (2022). A new section of *Hypocalymma* (Endl.) Endl., *H.* sect. *Grandiflora* Rye, Keighery & M.D.Barrett, is described. Like sect. *Hypocalymma*, the new section has seeds with a pitted testa, but it differs in having solitary axillary flowers with large petals greatly exceeding the length of the stamens. Its type species is *H. puniceum* C.A.Gardner and three of its five species are new: *H. inopinatum* Rye, Keighery & M.D.Barrett, *H. magnificum* Rye, Keighery & M.D.Barrett, and *H. polyandrum* Rye, Keighery & M.D.Barrett. Keys are given to the four sections of *Hypocalymma* and to the species of sect. *Grandiflora*. Four species have conservation priority.

Introduction

Hypocalymma (Endl.) Endl. is a south-western Australian genus of Myrtaceae tribe Chamelaucieae DC., currently with 28 published species and ten phrase-named species or subspecies listed on *Florabase* (Western Australian Herbarium 1998–). The high degree of morphological diversity within the genus, with obvious discontinuities between four main species groups, makes the development of an infrageneric classification of higher priority in *Hypocalymma* than in some other moderately large genera, such as *Astartea* DC. and *Micromyrtus* Benth.

In 2013, the previously named sections of *Hypocalymma* were reviewed (Rye *et al.* 2013) and it was concluded that only two of them should be recognised, sect. *Hypocalymma* with pitted seeds and sect. *Cardiomyrtus* Schauer with smooth or colliculate seeds. However, the morphological and molecular data suggested that two additional species groups needed to be recognised at some level, one with pitted seeds and the other with smooth seeds. The latter section was described, as *H.* sect. *Verticilla* Rye, and the other smooth-seeded section was fully revised.

The current paper presents additional molecular data and a full description of the new species group with pitted seeds, the ‘*Hypocalymma puniceum* group’ of Rye *et al.* (2013), as *H.* sect. *Grandiflora*

Rye, Keighery & M.D.Barrett. Section *Grandiflora* comprises five species, of which three are new and four have conservation priority.

Taxonomic history

For a history of *Hypocalymma* and its previously published sectional names see Rye *et al.* (2013). At the time the first sections were being established for the genus, by Schauer (1844), Turczaninow (1862) and Bentham (1867), all of the species treated here were unknown. The earliest collection of the plant group revised here was made by Charles Gardner in February 1923 and later in the same year used as the type of *H. puniceum* C.A.Gardner (Gardner 1923). Gardner noted that *H. puniceum* differed from the two species he indicated as being its closest relatives in its larger, solitary flowers and in having the style inserted in a depression. A second species was discovered in 1948 and recognised by the unpublished name *H. melaleuoides* C.A.Gardner ms.

Eventually, Strid and Keighery (2002) described Gardner's second species. They noted that *H. puniceum* and *H. melaleuoides* C.A.Gardner ex Strid & Keighery had stamens that were much shorter than the petals, and placed the two taxa together in their systematic ordering of the species. Three additional members of this species group were allocated informal names between 1998 and 2007.

Recent molecular studies of *Hypocalymma* species using the nuclear ribosomal DNA external transcribed spacer (ETS) region and several chloroplast regions (Wilson & Heslewood 2011; Rye *et al.* 2013), included a single species of the new section, *H. puniceum*. That species was very strongly supported (100% jk) as sister to a robust clade of four species of sect. *Hypocalymma*.

Methods

Taxonomic methods

Methods for obtaining measurements are as given in Rye *et al.* (2013). Distributions were plotted from data obtained from *Florabase* (Western Australian Herbarium 1998–), on maps showing the version 6.1 Interim Biogeographic Regionalisation for Australia (IBRA) regions (Department of the Environment, Water, Heritage and the Arts 2008).

DNA extraction and sequencing

A total of 20 specimens, representing each of the sections of *Hypocalymma* and outgroups from the related genera *Cyathostemon* Turcz. and *Seorsus* Rye & Trudgen of subtribe Astarteinae Rye & Peter G. Wilson, were used to generate ETS sequences for an expanded phylogeny of *Hypocalymma*. Voucher specimens for the sequences, and Genbank accession numbers are listed in Table 1.

Approximately 500 mg of leaf tissue was ground in liquid nitrogen, then again in Carlson extraction buffer (Csai *et al.* 1998), and genomic DNA extracted using a modified CTAB extraction protocol (Doyle & Dickson 1987): ground tissue was incubated for 15 mins at 65°C, proteins removed using a suspension of 24:1 chloroform : isoamyl alcohol mix shaken for 30 mins, followed by precipitation with an equal volume of isopropanol for 20–30 mins at -20°C, and the pellet washed with 70% ethanol. Between each step the supernatant or DNA pellet was recovered by spinning at 13,000 rpm for 10 mins. After drying, the DNA pellet was suspended in TE buffer.

Table 1. Voucher specimens for molecular sequencing.

Taxon	Voucher	PERTH barcode	Genbank accession number for ETS sequence
<i>Cyathostemon gracilis</i> Trudgen & Rye	<i>M. Bennett</i> 1212	08063974	OM650693
<i>C. verrucosus</i> Trudgen & Rye	<i>S. Reiffer</i> SRE 305	08284822	OM650694
<i>Hypocalymma angustifolium</i> (Endl.) Schauer	<i>C. Tauss</i> 6834	09376895	OM650695
<i>H. elongatum</i> (Strid & Keighery) Rye	<i>S. Hitchcock</i> & <i>R. Haycock</i> M 165	08674396	OM650696
<i>H. ericifolium</i> Benth.	<i>A. Matei</i> TB 108	08378193	OM650697
<i>H. hirsutum</i> Strid & Keighery	<i>G. Byrne</i> 3621	08291578	OM650698
<i>H. inopinatum</i> Rye, Keighery & M.D.Barrett	<i>S. Donaldson</i> , <i>G.T. Chandler</i> & <i>A. Munro</i> SD 2225	06375405	OM650699
<i>H. inopinatum</i> Rye, Keighery & M.D.Barrett	<i>B.L. Rye</i> 290156	08702942	OM650700
<i>H. jessicae</i> Strid & Keighery	<i>C. Tauss</i> 6200	08388830	OM650701
<i>H. longifolium</i> F.Muell.	<i>A.D. Crawford</i> ADC 2067	08271127	OM650702
<i>H. magnificum</i> Rye, Keighery & M.D.Barrett	<i>B.L. Rye</i> 290155	08702969	OM650703
<i>H. minus</i> (Strid & Keighery) Keighery	<i>M. Sowry</i> 109	07838786	OM650704
<i>H. polyandrum</i> Rye, Keighery & M.D.Barrett	<i>R. Davis</i> , <i>A.J. Perkins</i> & <i>B.L. Rye</i> DPR 12	08702950	OM650706
<i>H. puniceum</i> C.A.Gardner	<i>R. Davis</i> , <i>A.J. Perkins</i> & <i>B.L. Rye</i> DPR 5	08702934	OM650705
<i>H. robustum</i> (Endl.) Lindl.	<i>D.A. Mickle</i> & <i>M.L. Swinburn</i> 273	08123306	OM650707
<i>H. suave</i> Lindl.	<i>C. Tauss</i> 6848	09376879	OM650708
<i>H. sylvestre</i> Strid & Keighery	<i>M. Swinburn</i> 07	08439206	OM650709
<i>H. verticillare</i> Rye	<i>B.L. Rye</i> & <i>E.D. Middleton</i> BLR 250506	07131259	OM650710
<i>Seorsus clavifolius</i> (C.A.Gardner) Rye & Trudgen	<i>B.L. Rye</i> & <i>M.E. Trudgen</i> BLR 250109	07692404	OM650711
<i>S. clavifolius</i> (C.A.Gardner) Rye & Trudgen	<i>B.L. Rye</i> & <i>M.E. Trudgen</i> BLR 250119	07692382	OM650712

PCR amplifications were performed in 20 μ L volumes, and consisted of a final concentration of 67 mM Tris-HCl (pH 8.8 at 25°C), 16.6 mM $(\text{NH}_4)_2\text{SO}_4$, 0.45% Triton X-100, 0.2 mg/mL gelatin, 0.2 mM of each dNTP (all diluted 1:4 in 5 \times polymerisation buffer, Fischer Biotec, Subiaco, Australia), 2 mM MgCl_2 , 0.12% v/v DMSO, 0.06% v/v BSA, and 0.2 U Taq DNA polymerase (Fischer Biotec, Subiaco, Australia), 0.5 μ M final concentration of each primer per reaction and *c.* 10–500 mg of template DNA. The ETS region was amplified using the primers ETS-18S-R (GAGCCATTCGCAGTTTCACAG, Wright *et al.* 2001) and ETS-Kunz-F (CGTGCTGGTGCACCGAA, de Lange *et al.* 2010). The PCR

was performed on either an Applied Biosystems® Veriti® thermocycler, or GeneAmp® PCR System 9700, and used the following thermocycler profile: 95°C for 90 secs, 40× (95°C for 30 secs, 55°C for 1 min, 72°C for 90 secs), and a final extension of 72°C for 7 mins.

PCR products were verified and roughly quantified on a 2% agarose gel before removal of excess oligos by digest using 1 µL ExoSAP-IT® (Affymetrix USB) per 10 µL PCR product, then placed on a thermocycler at 37°C for 20 mins, 80°C for 15 mins, and finally held at 4°C.

Cycle sequence reactions were performed in 10 µL reaction volume, for both forward and reverse DNA strands, using BigDye® Terminator v. 3.1 chemistry (Applied Biosystems) with the same primers as for PCR, using the following PCR protocol: 96°C for 1 min, 25× (96°C for 10 secs, 50°C for 5 secs, 60°C for 4 mins). Excess dye was removed from cycle sequence reactions by precipitation in 80 µL of a 130:29:6 mix of 100% ethanol : H₂O : 3M sodium acetate mix held at room temperature for 10 mins, before centrifugation at 2500g for 45 mins, followed by washing the pellet in 70% ethanol. Fragment separation was carried out on an Applied Biosystems® 3500 Genetic Analyzer.

Chromatograms of contigs were first scored automatically then corrected manually and combined using CodonCode Aligner v. 3.5.7 (CodonCode Corporation, Dedham, MA, USA). Sequences were aligned using the MAAFT algorithm in Geneious® v. 6.1.7 (<https://www.geneious.com/>; Kears *et al.* 2012). Phylogenetic trees were reconstructed using maximum likelihood (ML) in RAxML v. 7.8.7 (Stamatakis 2006), using the GTR GAMMA substitution model option, 100 rapid bootstrap replicates, and no partitioning of the data. The substitution mode was chosen using MODELTEST (Posada & Crandell 1998).

Distinguishing features of section *Grandiflora*

Section *Grandiflora* differs from sections *Cardiomyrtus* and *Verticilla* in leaf and seed characters (see key below). It matches sect. *Hypocalymma* in having pitted seeds but differs in having only one viable flower per axil, and longer petals which are two to four times longer than the stamens (Figure 1). In sect. *Hypocalymma* the petals vary from about as long as the stamens to not much more than half their length. The dark veining of the petals in sect. *Grandiflora* (see Figure 1A) is a character that is absent or less obvious in most species belonging to other sections.

All members of sect. *Grandiflora* have horizontal ovules and seeds, whereas all members of sect. *Hypocalymma* have erect seeds except for *H. longifolium* F.Muell. *Hypocalymma longifolium* also differs from other members of the typical section in its more numerous ovules and more compressed fruit shape, but appears typical in all other characters. Molecular data (Figure 2) confirm that *H. longifolium* is correctly placed in sect. *Hypocalymma*.

Cultivation and hybridisation

The two rarest species of *Hypocalymma* sect. *Grandiflora*, which were known as *H. sp.* Lake King (R.W. Purdie 3936) and *H. sp.* Cascade (R. Bruhn 20/896 CAS), have been in cultivation for some time at Kings Park. Both ‘offer attractive grey-green foliage, large dark pink flowers for six months of the year and are excellent container plants’ (Anon. 2012: 20). *Hypocalymma puniceum* has also been in cultivation for some time (Elliot & Jones 1990). Attempts to produce hybrid seeds by cross-pollination between *H. angustifolium* (Endl.) Schauer *s. lat.* and members of the new section have



Figure 1. A – *Hypocalymma magnificentum* flowering stem with ovate leaves, a solitary flower at one node and a solitary bud at the node above; B – *H. polyandrum* flowering stem with a solitary flower and thick leaves with prominent glands. Images by Rob Davis from B.L. Rye 290155 (A) and R. Davis, A.J. Perkins & B.L. Rye DPR 12 (B).

failed (D. Grows pers. comm.) although *H. angustifolium* s. lat. can produce hybrids with a range of species belonging to its own group, sect. *Hypocalymma*.

Molecular sequencing

The RAxML phylogenetic tree based on an analysis of ETS sequences of 16 samples of *Hypocalymma*, including three undescribed taxa allocated phrase names, and four outgroups is shown in Figure 2. When rooted with *Cyathostemon* and *Seorsus*, the genus *Hypocalymma* is supported as monophyletic (82% BS). The two sections represented here by more than one sample (sect. *Hypocalymma* and the new sect. *Grandiflora*) are both monophyletic (97% and 89% BS respectively), to the limit of our species sampling. Within sect. *Grandiflora*, the subject of this paper, the phylogeny suggests two strongly supported subclades in the section. *Hypocalymma puniceum* s. str. and *H. puniceum* subsp. Cadoux (H. Demarz 10533) are strongly supported (100% BS) as sister taxa, with the latter herein described as *H. polyandrum* Rye, Keighery & M.D. Barrett. The unnamed taxa *H. sp.* Lake King (R.W. Purdie 3936) and *H. sp.* Cascade (R. Bruhn 20/896 CAS), are also strongly supported (100% BS) as sister taxa and are described here as *H. inopinatum* Rye, Keighery & M.D. Barrett and *H. magnificentum* Rye, Keighery & M.D. Barrett, respectively. *Hypocalymma melaleucoides* is the sole species of sect. *Grandifolia* not represented in the molecular tree.

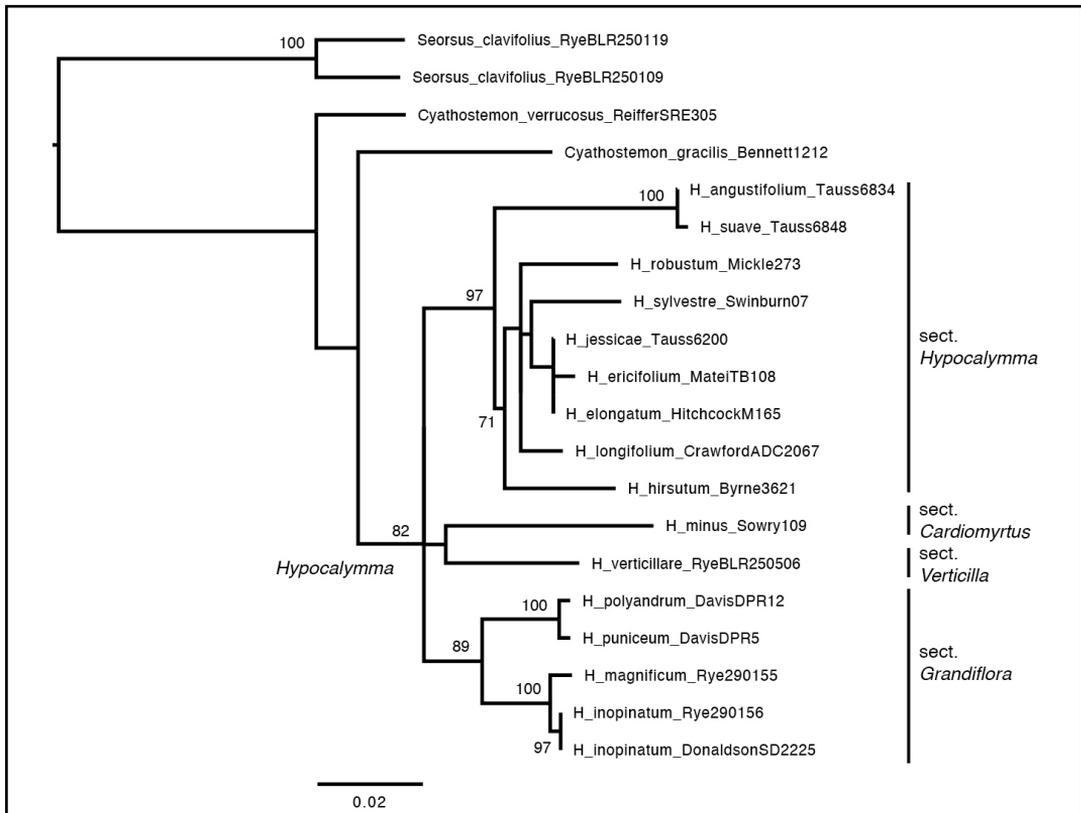


Figure 2. RAxML phylogenetic tree based on an analysis of ETS sequences of 16 samples of *Hypocalymma* and four outgroups. The tree is rooted with *Cyathostemon* and *Seorsus*. Bootstrap support values (BS) more than 70% are indicated above branches. Note that the genus *Hypocalymma* is supported as monophyletic, and the two sections represented by more than one sample (sect. *Hypocalymma* and the new sect. *Grandiflora*) are monophyletic.

Descriptions and keys

Key to sections of *Hypocalymma*

1. Leaves with margins recurved to revolute, discolorous with upper surface darker than undersurface. Stamens 10–50, connate at base or free. Seeds smooth or minutely colliculate, 0.8–1.7 mm long. Occurring south of Perth, restricted to the most humid parts of the South West Botanical Province
2. Young stems 3-angled, glabrous, each angle with a rounded ridge that is directly opposite the petiole above. Leaves in whorls of three, with oil glands in 2 or 3 main irregular rows. Androecium of 15–26 filaments, united for at least half of their length sect. **Verticilla**
- 2: Young stems either hairy or slightly to markedly 4-winged, the 4 angles or wings alternating with the leaves above and below. Leaves opposite, dotted with numerous minute oil glands. Androecium of 10–50 filaments, united only at base or free sect. **Cardiomyrtus**
- 1: Leaves with margins usually level or gently incurved to inrolled, concolorous or with upper surface paler than undersurface (if with upper surface darker then occurring north of Perth). Stamens 12–200, connate at base or for up to half their

length. Seeds shallowly to deeply reticulate-pitted, 1.3–2.5 mm long. Widespread in the South West Botanical Province

3. Flowers paired in all or many of the axils. Petals 2.5–5.5 mm long, yellow, pink or white, persistent or shed in fruit. Longest stamens about as long as or exceeding the petalssect. **Hypocalymma**
- 3: Flowers solitary in the axils (rarely also with an aborted flower present). Petals 6–14 mm long, mauve to deep pink, shed in fruit. Stamens all much shorter than the petals sect. **Grandiflora**

Hypocalymma sect. **Grandiflora** Rye, Keighery & M.D.Barrett, *sect. nov.*

Type: Hypocalymma puniceum C.A.Gardner.

Shrubs up to 1.5 m high, single-stemmed or multi-branched at base or sometimes recorded as lignotuberous, glabrous; flowering branchlets few-flowered (often just 1-flowered), the flowers solitary at each node (rarely also with an aborted flower present). *Leaves* opposite and decussate. *Petioles* absent or short. *Leaf blades* with incurved or level margins, concolorous or with upper surface slightly paler. *Peduncles* 0.4–2.5 mm long, 1-flowered. *Bracteoles* with incurved margins, entire. *Pedicels* short or absent. *Hypanthium* shortly cup-shaped or more obconic, with rather closely packed oil glands, which often appear somewhat sunken. *Sepals* 1–4 mm long, broad-based, broadly obtuse, entire, with an herbaceous part dotted with oil glands and a broad or narrow petaline border. *Petals* 6–14 mm long, mauve to deep pink, usually bright pink with multiple veins visible as darker markings, narrowed or shortly clawed at the base, entire, shed in fruit. *Staminodes* rare or absent. *Stamens* 35–130, in 2 or 3 series, united shortly at base into a continuous ring. *Longest filaments* filiform, much shorter than the petals, pink. *Anthers* yellow, with cells curved around a central connective gland, which is visible on the ventral surface. *Ovary* 2–4-locular, *c.* 1/2-inferior or largely inferior, the superior part with ridges corresponding with the junctions of the loculi; ovules 3–11 per loculus, horizontal. *Style* 2.5–5.5 mm long, pink, with base inset into a depression in the summit of the ovary; stigma very small. *Fruits* thick-walled; hypanthium becoming flattened and rugose-wrinkled as valves open. *Seeds* horizontal, crustaceous, irregularly ovoid or broadly so to almost reniform, 1.5–2.5 mm long; body unfacetted or somewhat facetted, shallowly to moderately deeply reticulate-pitted, pale to dark brown; inner protrusion (elaiosome) large, forming a whitish zone on inner surface of seed distal to the hilum, usually also extending laterally along each side of hilum but not or scarcely encircling it at the base; hilum towards base of inner surface. *Chaff pieces* strongly compressed and \pm reniform in outline or (if late-aborted) less compressed and of a more irregular shape, shorter than seeds, brown with a white inner protrusion, crustaceous.

Diagnostic characters. *Leaves* concolorous or with upper surface paler. *Sepals* 1–4 mm long. *Petals* 6–14 mm long, bright pink, shed in fruit. *Stamens* 35–130, in 2 or 3 series, united into a continuous ring at the base, much shorter than the petals, with anther cells curved around a central ventral connective gland. *Ovary* 2–4-locular, *c.* 1/2-inferior or largely inferior; ovules 3–11 per loculus. *Style* 2.5–5.5 mm long; base inset. *Seeds* reticulate-pitted, 1.5–2.5 mm long, pale to dark brown.

Size, distribution and phenology. Section *Grandiflora* contains five species and extends from Ballidu in the central wheatbelt south-east to Fitzgerald River National Park and Young River on the south coast of Western Australia.

Figure 3 shows the distributions of all four sections of *Hypocalymma*. As in sect. *Cardiomyrtus*, species belonging to the new section seem to have more extensive flowering periods than are found in most

members of sect. *Hypocalymma*. This may partly reflect the occurrence of both *Cardiomyrtus* (Figure 3A) and *Grandiflora* (Figure 3A) primarily towards the south coast where summer conditions tend to be less extreme and flowering periods are less likely to be restricted to the spring months, whereas sect. *Hypocalymma* (Figure 3B) has more than half of its species in the northern sandplains. The single known locality of sect. *Verticilla* (Figure 3B) is also near the south coast but the section is too poorly known for its phenology to be clear.

Etymology. From the Latin *grandi-* (large) and *-florus* (flowered), as these species have large flowers with petals much longer than the stamens.

Notes. The five species belonging to sect. *Grandiflora* never co-occur because there is no overlap in their geographic distributions (see Figure 4). Although this plant group never has more than one obvious flower per peduncle, *H. puniceum* sometimes has an abortive flower as well as the viable flower (see notes under that taxon).

Key to species of *Hypocalymma* sect. *Grandiflora*

1. Leaves linear in outline, thick. Ovary 2-locular in all or most flowers
 2. Young stems smooth to moderately rugose. Mature leaves with oil glands usually not very prominent; abaxial surface with 15–27 moderately closely packed oil glands in the 2 rows closest to (i.e. on either side of) the midvein. Stamens 35–55. (Ballidu–Lake Grace area) **H. puniceum**
 - 2: Young stems moderately to very rugose. Mature leaves with oil glands usually very prominent; abaxial surface with 9–14 widely spaced oil glands in the 2 rows closest to (i.e. on either side of) the midvein. Stamens 75–130. (Kirwan–Manmanning) **H. polyandrum**
- 1: Leaves narrowly ovate to obovate or elliptic. Ovary 3(4)-locular in all or most flowers
 3. Leaves sessile, ovate, 4–7 mm wide. Petals c. 14 mm long. Ovules 7–11 per loculus (Young River area) **H. magnificum**
 - 3: Leaves with a petiole 0.5–0.9 mm long; blade narrowly ovate or obovate to almost elliptic, 1.5–3 mm wide. Petals 6–10 mm long. Ovules 3–5 per loculus
 4. Young stems smooth. Leaf margins gently incurved. Petals at least 8–10 mm long (Lake King area) **H. inopinatum**
 - 4: Young stems minutely tuberculate. Leaf margins strongly incurved. Petals 6–8 mm long (Fitzgerald River NP) **H. melaleucoides**

Hypocalymma inopinatum Rye, Keighery & M.D.Barrett, *sp. nov.*

Type: east from Lake King, Western Australia [precise locality withheld for conservation reasons], 2 November 1990, R. W. Purdie 3936 (*holo*: PERTH 06073239; *iso*: CANB CBG 9011639).

Hypocalymma sp. Lake King (R. W. Purdie 3936), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub up to 1 m tall, with slender flowering stems. *Young stems* somewhat ridged below each petiole at first, becoming smooth and \pm terete. *Leaves* mostly antrorse to very widely antrorse. *Petioles* well defined, 0.5–0.8 mm long. *Leafblades* obovate to elliptic, 4.5–7 mm long, 2–3 mm wide, obtuse, with moderately incurved margins, entire, \pm concolorous or with abaxial surface darker than adaxial surface; abaxial surface convex, with 3 or 4 main rows of usually 8–13 oil glands; adaxial surface concave,

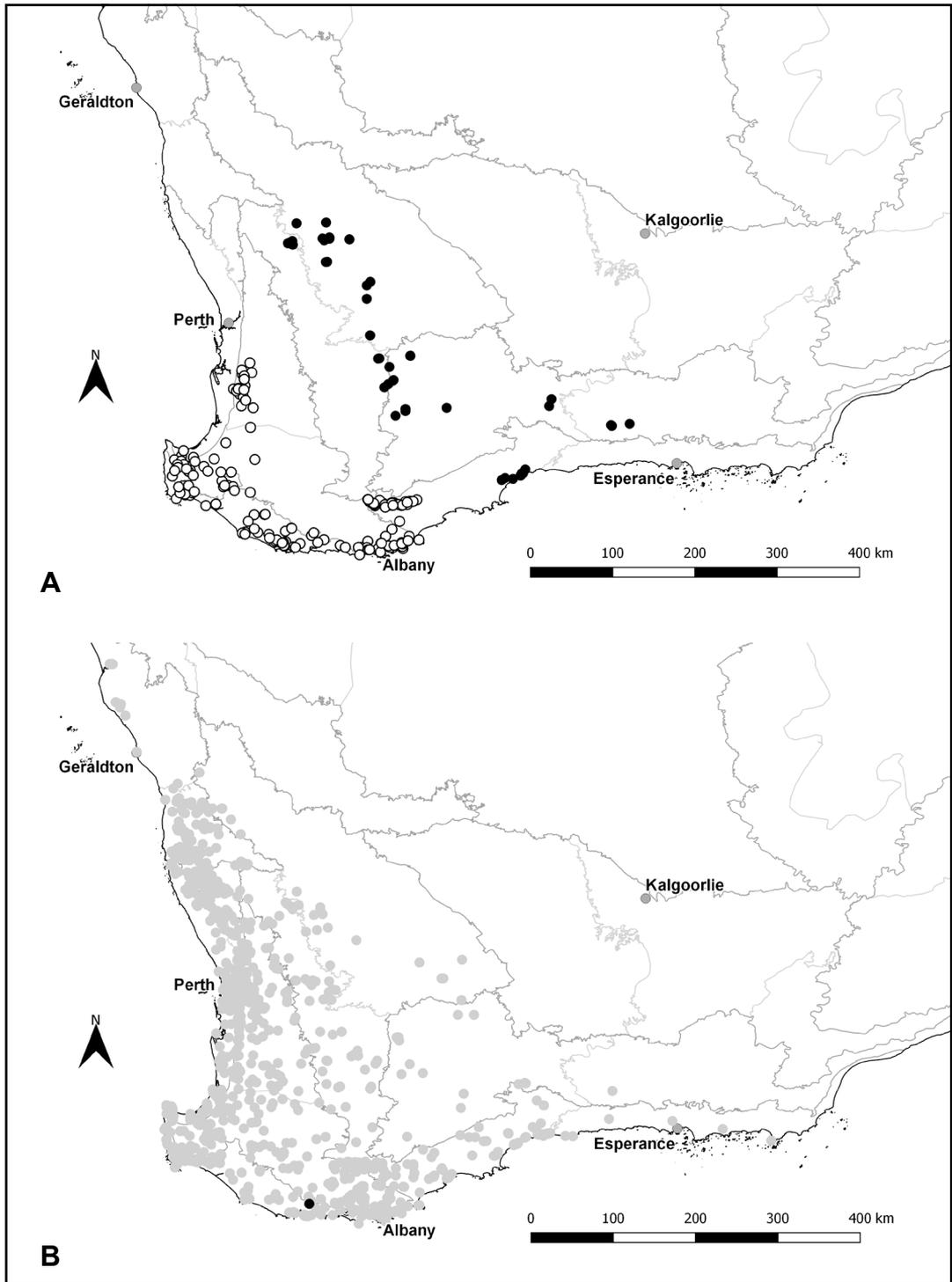


Figure 3. Distribution maps for the sections of *Hypocalymma*. A – *H. sect. Cardiomyrtus* (○) and *H. sect. Grandiflora* (●); B – *H. sect. Hypocalymma* (●) and *sect. Verticilla* (●).

with oil glands usually less conspicuous; apical point absent. *Peduncles* borne at 1–3 consecutive nodes, often with only one per node, 1-flowered, 1.5–2.5 mm long. *Bracteoles* herbaceous, often persistent in flower, 3–3.5 mm long. *Pedicels* 1–2 mm long. *Flowers* 15–20 mm diam. *Hypanthium* 1.3–1.7 mm long, 3–3.5 mm diam., dotted with inconspicuous oil glands; free part 0.6–1 mm long. *Sepals* depressed ovate, 2–2.5 mm long, 2.5–3 mm wide, herbaceous, with an extremely narrow hyaline margin. *Petals* 8–10 mm or more long. *Stamens* commonly 55–65. *Longest filaments* 3–4 mm long, united at base for *c.* 0.5 mm. *Anthers* 0.6–0.7 mm long. *Ovary* 3- or 4-locular, more than half inferior; summit moderately to prominently ridged; ovules 4 or 5 per loculus. *Style* *c.* 4 mm long; stigma 0.15–0.2 mm diam. *Fruits* *c.* half-inferior, depressed-globular, 3–3.5 mm long, *c.* 5 mm diam. *Seeds* 1.6–2.1 mm long, 0.7–1 mm wide, 0.8–1.3 mm thick, medium brown to dark red-brown; inner protrusion 1.4–1.5 mm long, 0.5–0.6 mm wide; hilum located within broad end of seed, 0.3–0.4 mm diam. *Chaff pieces* 1.2–1.4 mm long.

Diagnostic characters. *Leaves* shortly petiolate; blade obovate to elliptic. *Petals* 8–10 mm or more long. *Stamens* *c.* 60. *Longest filaments* 3–4 mm long. *Ovary* 3- or 4-locular; ovules 4 or 5 per loculus. *Seeds* 1.6–2.1 mm long, medium brown to dark red-brown.

Other specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 17 Sep. 1999, *S. Donaldson* 2225, *G.T. Chandler* & *A. Munro* (PERTH, CANB); cultivated in gardens surrounding the Western Australian Herbarium, Kensington, 15 Aug. 2014, *B.L. Rye* 290156 (PERTH).

Distribution and habitat. Occurs at two localities east of Lake King in the Mallee bioregion (Figure 4), one in shallow sandy soil on the crest of a low hill with *Melaleuca* spp. open shrubland and scattered emergent eucalypts, the other in white sand on laterite on a moderate slope with mallee eucalypts.

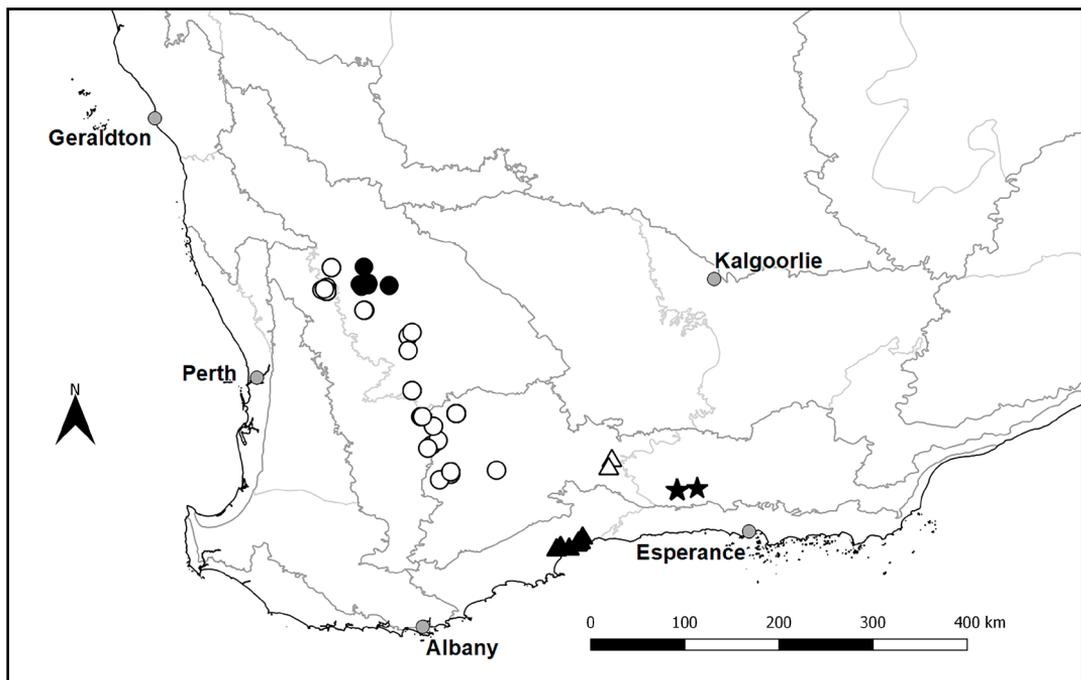


Figure 4. Distribution map for members of *Hypocalymma* sect. *Grandiflora*: *H. inopinatum* (△), *H. magnificum* (★), *H. melaleucoides* (▲), *H. polyandrum* (●) and *H. puniceum* (○).

Phenology. Flowers have been recorded from September to November and mature fruits in November.

Conservation status. Listed as Priority Two under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *H. sp.* Lake King (R.W. Purdie 3936). Described as uncommon at one locality and frequent at the other locality.

Etymology. From the Latin *inopinatus* (unexpected) as this very attractive species was first encountered by one of the authors (GJK) amongst the herbarium specimens and cultivated plants at Canberra rather than in its home state.

Vernacular name. Lake King Myrtle.

Affinities. Somewhat intermediate in morphology between *H. melaleucooides* and *H. magnificum* but differing in the characters given in the key and noted under those two taxa.

Notes. The habit of *H. inopinatum* needs further study as it is not yet known whether the species is lignotuberous and how well it regenerates after fires.

Most specimens have a 3-locular ovary on all flowers that have been examined, but on *R.D. Purdie* 3936 the ovary is equally 4-locular on the single flower present, and its single dehiscent fruit is 4-locular with one loculus small and abortive. This suggests that the flowers of this specimen are predominantly 4-locular, although one less mature fruit was found to be 3-locular with two functional loculi and an abortive loculus.

Hypocalymma magnificum Rye, Keighery & M.D.Barrett, *sp. nov.*

Type: Cascade Reserve, Western Australia [precise locality withheld for conservation reasons], 26 August 1996, *R. Bruhn* 20/896 CAS (*holo:* PERTH 04454154; *iso:* AD 99715263, CANB, K, MEL, ?NSW).

Hypocalymma sp. Cascade (*R. Bruhn* 20/896 CAS), in *G. Paczkowska & A.R. Chapman, West. Austral. Fl.: Descr. Cat.* p. 387 (2000); Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub 0.4–1 m tall, one specimen recorded as 0.3–0.4 m wide, single-stemmed at the base. *Young stems* ± terete, smooth. *Leaves* mostly widely spreading, sessile, ovate, 8–11 mm long, 4–7 mm wide, acute or obtuse, with moderately incurved margins, entire, ± concolorous, with midvein not protruding and scarcely visible; abaxial surface convex, dotted with numerous minute oil glands; adaxial surface concave; apical point absent. *Peduncles* usually borne at 1 or 2 consecutive nodes, often with only one per node, 1-flowered, 1–1.5 mm long. *Bracteoles* usually shed in bud, 4–5.5 mm long. *Pedicels* 0.7–1 mm long. *Flowers* 20–30 mm diam. *Hypanthium* 2–3 mm long, 3.5–5 mm diam.; free part 0.8–1.2 mm long. *Sepals* depressed ovate, 3–4 mm long, 4–5 mm wide, green with a broad pinkish margin or the margin pink with a narrow white extremity. *Petals* 11–15 mm long. *Stamens* 65–110. *Longest filaments* 3–4 mm long, united for *c.* 0.4 mm at base. *Anthers* 0.5–0.6 mm long. *Ovary* 3(4)-locular, largely inferior (only the ridges superior); ovules 7–11 per loculus. *Style* 3.7–4.3 mm long; stigma 0.15–0.2 mm diam. *Fruits* *c.* 1/2 inferior, depressed-globular, 3–4 mm long, 4–5 mm diam. *Seeds* 1.8–2.1 mm long, 1–1.3 mm wide, 1.1–1.3 mm thick, medium brown; inner protrusion 1.25–1.4 mm long, 0.6–0.8 mm wide; hilum located within the broad end of the seed, *c.* 0.4 mm diam. *Chaff pieces* 1.2–1.5 mm long. (Figure 1A)

Diagnostic characters. Leaves sessile, broadly ovate to cordate or ovate. Petals 11–15 mm long. Stamens 65–110. Longest filaments 3–4 mm long. Ovary 3(4)-locular; ovules 7–11 per loculus. Fruits c. 1/2 inferior, circular from top view. Seeds 1.8–2.1 mm long, medium brown.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 31 Aug. 2010, *E.D. Adams, J. Ford & C.D. Turley* EA 636 (PERTH); 10 Nov. 2007, *M. Crowhurst* 196 (KPBG, PERTH); Esperance Wildflower Show, 8 Sep. 2014, *J. Holmes* JLW 1412/05 (PERTH); cultivated in gardens surrounding the Western Australian Herbarium, Kensington, 30 Aug. 2013, *B.L. Rye* 290155 (NSW, PERTH).

Distribution and habitat. Occurs in the upper Young River area of the Mallee bioregion (Figure 4), where it is recorded in shallow sandy soil over granite adjacent to a rock sheet, with mallee *Eucalyptus* species.

Phenology. Flowers recorded from August to November and mature fruits in late August.

Conservation status. Listed as Threatened (Endangered) in Western Australia (Smith & Jones 2018) and Australia (Department of the Environment 2022) as *H. sp. Cascade* (R. Bruhn 20/896 CAS). Known from only one confirmed locality, where it was reported to be frequent in 2010 (*E.D. Adams, J. Ford & C.D. Turley* EA 636) with a note that it appeared to be a ‘disturbance opportunist’. The species is well established in cultivation.

Etymology. From the Latin *magnificus* (splendid), as this species has the largest, most spectacular flowers in the genus.

Vernacular name. Superb Myrtle.

Affinities. Distinguished from *H. inopinatum*, which seems to show the greatest similarity, by its broader, sessile leaves and larger flowers with more numerous stamens and ovules.

Notes. *Hypocalymma magnificum* lacks a lignotuber and is readily killed by fires and mechanical clearance; however, it reproduces readily by seed. The holotype has been parasitised by *Cassytha*.

One flower examined from each of the field-collected specimens of *H. magnificum* had a 4-locular ovary, suggesting that this character may be more frequent in this species than in other members of the genus; however all of the fruits examined were 3-locular.

The cultivated specimen *B.L. Rye* 290155, derived from a cutting taken in Kings Park, had developed a very stout basal stem, over 20 mm across, about two years after it was planted. Although its petals were up to 15 mm long, they had an incurved margin, restricting the flower diameter to 25 mm. Its stamen filaments were deep pink or maroon.

Hypocalymma melaleuroides C.A. Gardner ex Strid & Keighery, *Nord. J. Bot.* 22: 564 (2002). *Type:* Fitzgerald River National Park, Western Australia [precise locality withheld for conservation reasons], 6 October 1993, *C.A. Robinson* 1187 (*holo:* PERTH 03555801; *iso:* CANB 599027, NSW 441695, PERTH 03369455).

Hypocalymma sp. Marshes Beach (C.R. Hart 11), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub 0.3–0.5 m high, commonly 0.55–0.8 m wide. *Young stems* ± terete, densely and minutely tuberculate. *Leaves* widely spreading or antrorse. *Petioles* well defined, 0.5–0.9 mm long. *Leaf blades* narrowly ovate to elliptic, 4–6 mm long, 1.5–2 mm wide, entire, margins strongly incurved; abaxial surface darker than adaxial surface, convex, with midvein not protruding and scarcely visible, dotted with numerous minute oil glands; adaxial surface concave, with oil glands similar to those on abaxial surface but more obvious because of the paler background colour; apical point absent. *Peduncles* borne at 1–3 consecutive nodes, often with only one per node, 1-flowered, 0.5–2 mm long. *Bracteoles* caducous or shed in flower, 3–4 mm long. *Pedicels* c. 1 mm long. *Flowers* 13–17 mm diam. *Hypanthium* 1.5–2 mm long, c. 3 mm diam.; free part 0.4–0.6 mm long. *Sepals* depressed ovate, 1–2 mm long, 2.3–2.7 mm wide, green with a broad, whitish to deep pink border. *Petals* 6–8 mm long. *Stamens* 35–55. *Longest filaments* 3–4 mm long, united for c. 0.4 mm at base. *Anthers* 0.4–0.45 mm long. *Ovary* 3-locular, c. 1/2 inferior; ovules 3–5 per loculus. *Style* 2.5–3.5 mm long; stigma 0.15–0.2 mm diam. *Fruits* c. 1/2 inferior, depressed-globular, 3–3.5 mm long, c. 5 mm diam. *Seeds* 1.5–1.7 mm long, 0.6–0.8 mm wide, c. 0.8 mm deep including inner protrusion, medium to dark brown; inner protrusion 1.35–1.4 mm long, 0.45–0.5 mm wide; hilum towards base of inner surface, 0.3–0.4 mm diam. *Chaff pieces* 1.1–1.2 mm long.

Diagnostic characters. *Young stems* ± terete, minutely tuberculate. *Leaves* shortly petiolate; blade narrowly ovate to elliptic. *Petals* 6–8 mm long. *Stamens* 35–55. *Longest filaments* 3–4 mm long. *Ovary* 3-locular; ovules 3–5 per loculus. *Seeds* 1.5–1.7 mm long, medium to dark brown.

Selected specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 20 Sep. 1948, C.A. Gardner 9154 (PERTH); 16 Sep. 1990, C.R. Hart 11 (PERTH); 1 Nov. 1975, K.R. Newbey 4906 (PERTH); 22 Sep. 2011, D.A. Rathbone DAR 712 (PERTH).

Distribution and habitat. Occurs in Fitzgerald River National Park in the Esperance Plains bioregion (Figure 4), in heath on red soil over quartzite.

Phenology. Flowers have been recorded from September to February and fruits from October to February.

Conservation status. Listed as Priority Two under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–). The precise extent of the distribution of *H. melaleuroides* is uncertain as two collections lack exact localities, but the species occurs in a large national park and is only known from a small area that appears to be about 20 km long.

Vernacular name. Fitzgerald Myrtle.

Affinities. This very distinctive species is closest in its morphology to *H. inopinatum*. Apart from the differences used in the key it has narrower leaves and tends to be a lower shrub.

Notes. The species was listed in Paczkowska and Chapman (2000: 387) as '*Hypocalymma melaleuroides* Keighery & Strid ms'. It has the smallest flowers in sect. *Grandiflora* but still among the largest found in the genus. More material is needed to give a more complete description of the flowers, as each specimen has very few flowers and only one has good, fully opened flowers.

Hypocalymma polyandrum Rye, Keighery & M.D.Barrett, *sp. nov.*

Type: east of Cadoux, Western Australia [precise locality withheld for conservation reasons], 1 December 2008, *M.E. Trudgen* MET 23335 (*holo:* PERTH 08215294; *iso:* CANB, K, MEL, NSW).

Hypocalymma puniceum subsp. Cadoux (H. Demarz 10533), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 8 March 2022].

Shrub usually low and spreading, 0.15–1.5 m high, 0.8–2 m wide. *Young stems* whitish, 4-angled and deeply 4-ridged to slightly 4-winged at first, moderately to very rugose, sometimes with very prominent oil gland swellings. *Leaves* antrorse or widely spreading. *Petioles* poorly or well defined, 0.4–1 mm long. *Leaf blades* linear in outline, 10–13 mm long, 0.6–1 mm wide, 0.6–1.2 mm thick, concolorous, obtuse, entire; abaxial surface convex or deeply convex, grooved along the middle, with 1 or 2 main rows of usually very prominent, widely spaced oil glands on each side of the groove, the innermost rows with 9–14 glands; adaxial surface ± flat, grooved along the middle; apical point recurved, 0.15–0.25 mm long. *Peduncles* borne at 1–3 nodes per branchlet but commonly just one node, 1-flowered, 0.4–1 mm long. *Bracteoles* shed in late bud or in flower, 1.5–2.5 mm long, obtuse. *Pedicels* ± absent. *Flowers* 19–23 mm diam. *Hypanthium* 1–1.5 mm long, 3–3.5 mm diam.; free part absent or up to 0.4 mm long. *Sepals* usually depressed ovate to almost circular, with the margin incurved, 3–4.5 mm long, 3–4.5 mm wide, with a green herbaceous base surrounded by a pink area, with a white or pale pink margin 0.3–0.5 mm wide. *Petals* 8–11.5 mm long. *Stamens* 75–130. *Longest filaments* 3.5–4.5 mm long, united for *c.* 0.3 mm at base. *Anthers* 0.5–0.6 mm long. *Ovary* 2-locular, *c.* half-inferior; ovules 3 or 4 per loculus. *Style* 4.5–5 mm long; stigma 0.15–0.2 mm diam. *Fruits* largely to almost fully superior, depressed ovate to transversely elliptic from side view, somewhat compressed from top view, 3.2–3.5 mm long, 4–5 mm wide; hypanthium somewhat rugose. *Seeds* 2–2.5 mm long, 1.3–1.5 mm wide, 1.3–1.5 mm deep including inner protrusion, very pale at first, becoming golden brown; inner protrusion 1.5–1.6 mm long, 1.1–1.4 mm wide; hilum *c.* 0.5 mm across. *Chaff pieces* 1.3–1.6 mm long. (Figure 1B)

Diagnostic characters. *Young stems* moderately to very rugose. *Leaf blades* linear in outline, thick. *Petals* 8–11.5 mm long. *Stamens* 75–130. *Longest filaments* 3.5–4.5 mm long. *Ovary* 2-locular; ovules 3 or 4 per loculus. *Seeds* 2–2.5 mm long, very pale to golden brown, very minutely reticulate-pitted.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 Nov. 2008, *J.M. Collins* 566 & 568 (PERTH); 15 Oct. 2013, *A. Crawford* ADC 2376 (PERTH); 15 Oct. 2013, *R. Davis, A.J. Perkins & B.L. Rye* DPR 12 (AD, PERTH); 20 Dec. 1984, *H. Demarz* 10533 (CANB, PERTH); Mar.–Apr. 1960, *B. Rosier* 267 (PERTH); 30 May 1985, *B.H. Smith* 575 (CBG, HO, MEL, NSW, PERTH); 16 Nov. 1996, *L. Sweedman* S 4375 (PERTH).

Distribution and habitat. Extends from Kirwan south to near Manmanning in the Avon Wheatbelt bioregion (Figure 4) on yellow sand, on sand over lateritic or with gravel, often in mallee shrubland.

Phenology. Flowers have been recorded from April to December. Young or mature fruits are present on most of the specimens, i.e. apparently throughout the flowering season.

Conservation status. Listed as Priority One under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *H. puniceum* subsp. Cadoux (H. Demarz 10533). Its known distribution is *c.* 30 km long.

Etymology. From the Greek *poly-* (many-) and *-andrus* (man, i.e. stamen), as its maximum recorded stamen number of c. 130 is the highest known in sect. *Grandiflora* and among the highest in the genus as a whole. Only *H. sylvestre* Strid & Keighery has a significantly larger average stamen number.

Vernacular name. Cadoux Pink Myrtle.

Affinities. This species and its close relative *H. puniceum* are readily distinguished from other species of sect. *Grandiflora* by their narrow, thick leaves and 2-locular ovary. They also differ in having paler seeds with a finer reticulum of pits.

Hypocalymma polyandrum occurs east of the northernmost part of the distribution of *H. puniceum*. It can be readily distinguished from *H. puniceum* by its more numerous stamens and by a combination of vegetative characters, including having fewer oil glands on its mature leaves. Its leaves tend to be much more rugose than in all other members of sect. *Grandiflora*.

Hypocalymma puniceum C.A.Gardner, *J. & Proc. Roy. Soc. Western Australia* 9: 103–104 (1923).
Type: Bending, Western Australia, 6 February 1923, C.A. Gardner 1922 (*holo:* PERTH 01637169; *iso:* PERTH 01637177, PERTH 01637185, PERTH 01637193, PERTH 02352036).

Illustration. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 3A: 89 (1980).

Shrub 0.1–1 m high, 0.1–1 m wide. *Young stems* 4-angled and deeply 4-ridged to slightly 4-winged, smooth or rarely moderately rugose. *Leaves* mostly appressed or closely antrorse, sometimes some of them widely antrorse. *Petioles* poorly or well defined, 0.4–1 mm long. *Leaf blades* linear in outline, 8–16 mm long, 0.5–1.1 mm wide, 0.5–0.7 mm thick, concolorous, crenulate or entire, obtuse; abaxial surface grooved to convex, with 1 or 2 main rows of moderately closely packed, sometimes prominent oil glands on each side of the groove, the innermost rows with 15–27 glands; adaxial surface \pm flat, narrowly grooved, with 1 main row of sometimes prominent oil glands on each side of the groove; apical point slightly to markedly recurved, 0.2–0.5 mm long. *Peduncles* borne at 1–3(–5) consecutive nodes, mostly 1-flowered (but sometimes with a second abortive flower present), 0.4–1 mm long; secondary axis (when present) 0.5–1.5 mm long. *Bracteoles* usually shed in late bud or in flower, 1.5–3 mm long, often shortly pointed at apex. *Pedicels* \pm absent. *Flowers* 15–30 mm diam. *Hypanthium* 1–1.2 mm long, 3–3.5 mm diam.; free part absent or up to 0.4 mm long. *Sepals* depressed ovate to broadly elliptic, with the margin incurved, 2.5–3.5 mm long, 3–4.5 mm wide, with the green herbaceous base sometimes surrounded by a pink area, with a white or pale pink margin 0.5–0.7 mm wide. *Petals* 9–13 mm long. *Stamens* 35–55. *Longest filaments* 3.5–5 mm long, united for 0.2–0.25 mm at base. *Anthers* 0.35–0.5 mm long. *Ovary* 2-locular, c. half-inferior or largely superior; ovules 3 per loculus. *Style* 3.5–5.5 mm long; stigma 0.15–0.2 mm diam. *Fruits* \pm fully superior, depressed ovate to transversely elliptic from side view, somewhat compressed from top view, 2.5–3.5 mm long, 3.5–4.5 mm wide; hypanthium somewhat rugose. *Seeds* 1.6–2.4 mm long, 0.9–1.1 mm wide, 1–1.5 mm deep including inner protrusion, pale to medium golden brown; inner protrusion 1.2–1.5 mm long, 0.5–0.6 mm wide; hilum c. 0.4 mm across. *Chaff pieces* 1–1.3 mm long.

Diagnostic characters. *Young stems* smooth to moderately rugose. *Leaf blades* linear in outline, thick. *Petals* 9–13 mm long. *Stamens* 35–55. *Longest filaments* 3.5–5 mm long. *Ovary* 2-locular; ovules 3 per loculus. *Seeds* 1.6–2.4 mm long, very pale to golden brown, very minutely reticulate-pitted.

Selected specimens examined. WESTERN AUSTRALIA: Boolanelling Reserve, between Williams and Copestakes Rds, 9 Apr. 2017, *G. Byrne* 6197 (PERTH); Amery–Benjabearing Rd, c. 6 km W of Minnivale, 16 July 2009, *J.M. Collins* 615 (PERTH); at gravel pit on Amery–Benjabearing Rd, W of Minnivale, 15 Oct. 2013, *R. Davis, A.J. Perkins & B.L. Rye* DPR 5 (PERTH); Doyles Rd, 26 km from Kulin Post Office, NW of Kulin, 8 Feb. 2002, *J.P. Francis* 73 (PERTH); 2 miles [3 km] S of Tarin Rocks, 19 Mar. 1970, *M.D. Tindale* 185a & *B.R. Maslin* (A, CANB, K, NSW, PERTH).

Distribution and habitat. Extends from Ballidu in the Avon Wheatbelt bioregion south-east to the Lake Grace area in the Mallee bioregion (Figure 4), with an unconfirmed record from Lake King, on lateritic sand and gravel in shrubland or heath.

Phenology. Flowers have been recorded throughout the year, especially during the summer months. Fruits would therefore also be borne throughout the year.

Conservation status. Not considered to be at risk.

Vernacular name. Large Myrtle.

Typification. In the protologue, Gardner (1923: 104) stated ‘The Type is No. 1922 of the Forests Department Herbarium.’, so the specimen (PERTH 01637169) derived from that herbarium is cited as the holotype. However, Gardner gave the date as 5 February 1923, whereas the holotype and one of the isotypes (PERTH 02352036) give the date as 6 February 1923.

Two other sheets presumed to be isotypes (PERTH 01637185, PERTH 01637193) give the date just as being in February 1923 and have no collection number. The final isotype (PERTH 01637177) has the date as 5 February 1923 and is the only one to give ‘flowers bright pink’ as by Gardner (1923) but has the collection number incorrectly given as 1422.

Affinities. See notes under its close relative *H. polyandrum*.

Notes. *Hypocalymma puniceum* was the only member of the section to have been named prior to the publication of Blackall and Grieve’s (1980) key, in which it is illustrated and accurately keyed on page 89. Like *H. polyandrum*, it has thick leaves, probably as an adaptation to its occurrence in drier habitats than those of the other three members of the genus, which have much broader leaves with incurved margins. Its leaves are usually dotted with dark oil glands, which are more or less flush with the surface or moderately prominent. According to Strid and Keighery (2002: 564), *H. puniceum* ‘appears after fires in large numbers then becomes progressively rarer until another fire’. It has also been recorded regenerating from a lignotuber after fires by K. Brooks (pers. comm.).

Hypocalymma puniceum has a short peduncle, 0.4–0.6 mm long, but sometimes has its single viable flower borne on a longer secondary axis, up to 1.5 mm long, which is angled out to one side of the main peduncle. In this case the peduncle also bears an abortive flower on the other side. The lop-sided nature of the 1-flowered peduncles is distinctive and possibly shows evidence of reduction of flower number per peduncle from two to one.

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