

A revision of the south-western Australian genus *Astartea* (Myrtaceae: Chamelaucieae)

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Abstract

Rye, B.L. A revision of the south-western Australian genus *Astartea* (Myrtaceae: Chamelaucieae). *Nuytsia* 23: 189–269 (2013). *Astartea* DC. is a long-established, taxonomically difficult genus closely related to *Cyathostemon* Turcz. and *Hypocalymma* (Endl.) Endl. It is restricted to damp habitats of the South West Botanical Province of Western Australia. In this revision of the genus, 22 species are recognised, including 11 new species (*A. cicatricosa* Rye & Trudgen, *A. decemcostata* Rye, *A. eobalta* Rye, *A. graniticola* Rye & Trudgen, *A. middletonii* Rye, *A. montana* Rye, *A. onycis* Rye & Trudgen, *A. schaueri* Rye & Trudgen, *A. reticulata* Rye, *A. transversa* Rye and *A. zephyra* Rye & Trudgen) and one new subspecies (*A. aspera* Schauer subsp. *riparia* Rye). A presumed hybrid between *A. arbuscula* (R.Br. ex Benth.) Rye and *A. corniculata* Schauer is also described. Distinguishing characteristics, insect associations and other aspects of the biology of *Astartea* are discussed and illustrated.

Introduction

The myrtaceous genus *Astartea* DC. belongs to the large tribe Chamelaucieae DC. and is restricted to damp habitats in the south-west of Western Australia. It is a well defined genus, with many similar species presumably resulting from a relatively recent and rapid radiation. Consequently, it is taxonomically difficult, with many qualitative characteristics of the leaves and flowers being remarkably constant. Some quantitative characters, such as flower size, stamen number and ovule number, are highly variable in the genus and potentially valuable in distinguishing species; however, a large amount of quantitative variation also occurs within some species. With many species overlapping in range and often occurring in close proximity, there is ample opportunity for hybridisation to further complicate the taxonomy of the genus.

Although *Astartea* was one of the earliest genera of its tribe to be named, it has not been revised since Bentham (1867) responded to the taxonomic difficulty of the genus by synonymising most of the previously published taxa under the type species, *A. fascicularis* (Labill.) DC. As a result, the authors of many flora surveys and other studies (e.g. Dodd *et al.* 1984; Lyons 1988; Yeates 1992; Richardson *et al.* 2006) have recorded any *Astartea* species they encountered as *A. fascicularis*.

The aim of the taxonomic revision presented here is to name all new taxa for which adequate collections and other data are available, to provide a workable key for the identification of all named taxa, and to

briefly examine the biological significance of a range of morphological characters observed in *Astartea*. Future studies are likely to increase the number of species recognised beyond the 22 described here.

Taxonomic history

The first specimen of *Astartea* was apparently collected on Observatory Island, Archipelago of the Recherche, in December 1792 by Jacques de Labillardière, the naturalist on a French expedition led by d'Entrecasteaux (see Duyker 2003). Labillardière (1806) named the species *Melaleuca fascicularis* Labill. However, De Candolle (1828) created the new genus *Astartea* for this species because it differed from *Melaleuca* L. in having pedicellate flowers and in having stamen fascicles opposite the sepals rather than the petals (De Candolle 1842).

Over thirty years elapsed before a second species of *Astartea* was described, this one placed in the genus *Baeckea* L. under the name *B. affinis* Endl. (Endlicher 1837). Schauer (1843, 1844) renamed Endlicher's species as an *Astartea* and described six new species. A further two species descriptions were published by Turczaninow (1852), although one of these taxa is now regarded as a synonym.

During the same period that the number of described species of *Astartea* rose to nine, the related genera *Hypocalymma* (Endl.) Endl. (Endlicher 1837, 1840) and *Cyathostemon* Turcz. (Turczaninow 1852) were established. The latter genus was unknown to Schauer, who died in 1848; however, he made a significant contribution to the taxonomy of *Hypocalymma* as well as *Astartea* and was evidently aware of morphological similarities between the two genera. In his systematic ordering of the myrtaceous genera, Schauer (1843, 1844) placed *Astartea* last, directly after *Hypocalymma*. It was not until 2002, when the first molecular data were published (Lam *et al.* 2002), that the close relationship between *Astartea* and *Hypocalymma* was again recognised.

Mueller (1859, 1860) broadened the delimitation of *Astartea* when he named *A. ambigua* F.Muell. and *A. intratropica* F.Muell., both of which showed marked morphological differences from the previously named *Astartea* species. The latter species was also atypical in occurring in the Northern Territory as all other species were restricted to the south-west of Western Australia. The former species has now been transferred to *Cyathostemon* (Rye & Trudgen 2012) while the latter has been placed in the genus *Seorsus* Rye & Trudgen (Rye & Trudgen 2008).

In his treatment of *Astartea* for *Flora Australiensis*, Bentham (1867) recognised three species, including both of Mueller's atypical species. He synonymised all south-western Australian species with antisepalous fascicles under the type species *A. fascicularis*, although he noted that this broadly circumscribed taxon was extremely variable. Bentham also named two species (*Baeckea arbuscula* R.Br. ex Benth. and *B. astarteoides* Benth.) that are now considered to be typical members of *Astartea* but which have such low stamen numbers that antisepalous fascicles are rarely, if ever, formed. He was concerned, however, that *Astartea* could only be distinguished by having its stamens 'more or less united at the base' (Bentham 1867: 89) and was well aware (see Bentham 1868: 115, 134) that reliance on this single character difference between *Astartea* and *Baeckea* resulted in an artificial separation of the two genera.

Although Niedenzu (1893) synonymised *Astartea* under *Baeckea*, Australian botanists continued to follow the generic limits given in *Flora Australiensis*. Gardner (1927, 1942) named two more atypical species, *A. heteranthera* C.A.Gardner and *A. clavifolia* C.A.Gardner. Like the two species named previously by Mueller (1859, 1860), the former of Gardner's species is now placed in *Cyathostemon* and the latter in *Seorsus*.

Since 1867, no new members of *Astartea s. str.* have been formally named except for one variety described by Domin (1923). The need for additional species to be recognised in the genus was noted in the *Astartea* treatment for *Flora of the Perth Region* (Rye 1987) although the *status quo* of recognising only one species, as *A. fascicularis*, was the only practical option at that time.

Between 1994 and 1997, Malcolm Trudgen established informal names for ten of the taxa with antisepalous fascicles of stamens. Most of these informal names were used in *Flora of the south west* (Wheeler *et al.* 2002), which gave brief descriptions for nine of the twelve species now recognised in the region covered by that flora.

Current study

The current study of *Astartea* began in 2002 with the examination of type material. This led to the reinstatement in *FloraBase* (Western Australian Herbarium 1998–) and Rye (2006) of most of the species named by Schauer (1843, 1844) and Turczaninow (1852). New combinations were also made (Rye 2006) for three species of *Astartea* that had been described as members of the genus *Baeckea*. Although these published names have now replaced half of the informal names that were in use in 2002, the number of species known by informal names has risen as additional new taxa have been delimited.

The circumscription of *Astartea* adopted in recent publications (Rye 2006; Rye & Trudgen 2008, 2012) agrees with Turczaninow's (1852) concept of the genus, from which he excluded *Cyathostemon*.

Methods

Where possible, flower diameter was measured on fresh material in the field; this was found to correspond well with measurements made on the same material after pressing. All other measurements were made from herbarium specimens. Holotypes of the new species are all housed at PERTH.

Leaf descriptions were taken from typical mature leaves, excluding the single leaf that often subtends each fascicle of leaves, as this is more flattened and broader than usual. Length measurements of bracteoles were taken from the oldest buds on which they were still present, or from flowers if they were sufficiently persistent. Measurements of peduncles, pedicels and styles were also taken when they were fully mature, i.e. in late flower or in fruit. It is particularly important for the pedicel to be measured after it has fully extended as its length relative to that of the peduncle increases as it matures.

Only the outermost two sepals were measured as these are the longest and have the greatest development of the dorsal ridge or horn. All style measurements given here include the immersed portion, requiring a fully mature flower or fruit to be dissected to reveal the complete style. Fruit measurements were taken from mature fruits before they either dehisce or are shed unopened from the plant. Fruit length excludes any attached floral parts but the width includes the adnate hypanthium.

Distributions were plotted, using DIVA-GIS Version 5.2.0.2, from data obtained from *FloraBase* (Western Australian Herbarium 1998–), onto maps showing the *Interim Biogeographic Regionalisation for Australia* (IBRA 6.1) regions (Department of the Environment, Water, Heritage and the Arts 2008).

Multiple images of flowering stems, seeds and insect scales were taken with a Nikon Digital Camera Head (DS-5M) controlled by a DS Camera Control Unit (DS-L1) and a montage of the images was collated using Synoptics Auto-Montage Pro Version 5.03.0061 software.

Morphology

This section outlines the morphological characters that either define the genus or are of value in delimiting its species. Many of these characters are illustrated in Figures 1–4.

Vegetative characters

Habit and indumentum. *Astartea* species have a wide variety of growth forms, ranging from dwarf shrubs 0.1–0.4 m high to small trees, reaching a maximum height of at least 5 m. Many species have lignotubers (Figure 1A) but others are single-stemmed or spread laterally by suckering. See the *Growth forms* section below for more details. All parts of the plants are glabrous and many of them are dotted with oil glands.

Young stems. Young stems are 4-angled (Figure 1F) and sometimes slightly to distinctly winged along each angle, this character becoming pronounced in *A. laricifolia* Schauer (Figure 1E). Crown-shaped outgrowths, consisting of an oil gland surrounded by a protruding rim with a number of projections, occur on young stems of *A. aspera* Schauer (Rye & Trudgen 2008: Figure 1A) and *A. muricata* Turcz. (Figure 2A). They often also occur on the leaves and peduncles of those species, but are not as prominent there as on the stems.

Leaf fascicles. Leaves tend to be densely clustered on short side shoots (i.e. where new branchlets form in the axils without elongation of internodes) in most species, with some species showing a much stronger tendency for this than others. For example, leaf fascicles are well developed in *A. glomerulosa* Schauer (Figure 1C) but widely spaced leaves are more common in *A. affinis* (Endl.) Rye (Figure 1B). During growth spurts, however, all species produce some rapidly growing stems with widely separated pairs of leaves.

Leaf morphology. All species have a narrow, entire blade, which is generally thicker than wide and has its maximum width and thickness towards the apex. In most cases the blade has sharply defined angles between a deep abaxial surface and flat to grooved adaxial surface. The petiole is short and often poorly defined. Small hair-like processes, which are presumed to be reduced, divided stipules (see Johnson & Briggs 1984: 741), are often present in the axils of young leaves (Figure 3C).

Inflorescence

Flower arrangement. Flowers are usually solitary in the axils. They are subtended by a pair of bracteoles, which are usually borne at the junction (see Figure 3D) of a dorsiventrally compressed peduncle (sometimes compressed only towards the base) and a more or less terete pedicel. Pedicels are sometimes absent in the two species (*A. arbuscula* (R.Br. ex Benth.) Rye and *A. transversa* Rye) with the smallest flowers. In most species they tend to be shorter than, sometimes to as long as, the peduncles; however, in *A. aspera* and *A. laricifolia* they tend to be distinctly longer than the peduncles. *Astartea muricata* is unique in having up to three flowers on each peduncle, occasionally with more than one peduncle per axis, although some specimens have uniformly 1-flowered axils. Figure 2A illustrates a 2-pedunculate, 4-flowered axil in this species, the abaxial peduncle 1-flowered and the adaxial peduncle 3-flowered. *Astartea zephyra* Rye & Trudgen includes one atypical specimen (*D. Cooper* 162) in which there are occasionally two peduncles per axil, both 1-flowered.



Figure 1. Field images. A – regrowth from *Astartea lignotuber* at Moorialup Nature Reserve in January 2010; B – flowering stem of *A. affinis* with jewel beetle; C – buds and flowers of *A. glomerulosa*; D – *A. granitica* flowers and fruits; E – winged flowering stems of *A. laricifolia*; F – 4-angled flowering stems and galled shoot of *A. scoparia*. Images from B.L. Rye 221202 (B); B.L. Rye 221210 & R.W. Hearn (C); B.L. Rye 221240 & R.W. Hearn (D); B.L. Rye 230145 & R.W. Hearn (E) and B.L. Rye 221224 & R.W. Hearn (F). Taken by P.J. Rye (A–D, F) and B.L. Rye (E).

Bracteoles. Bracteoles overlap at first, enclosing the young buds, which may have little or no pedicel. The apex of the bracteole tends to be hooded (Figure 3D) and sometimes has a subterminal point (Figure 3H). As buds mature the pedicel tends to elongate much more markedly than the peduncle and the bud usually emerges from its subtending bracteoles (Figure 3C) well before anthesis. Usually the bracteoles are caducous or deciduous, with one (Figure 3D) or both (Figure 3A) shed before the buds reach maturity. However, in a few species such as *A. schaueri* Rye & Trudgen, the bracteoles

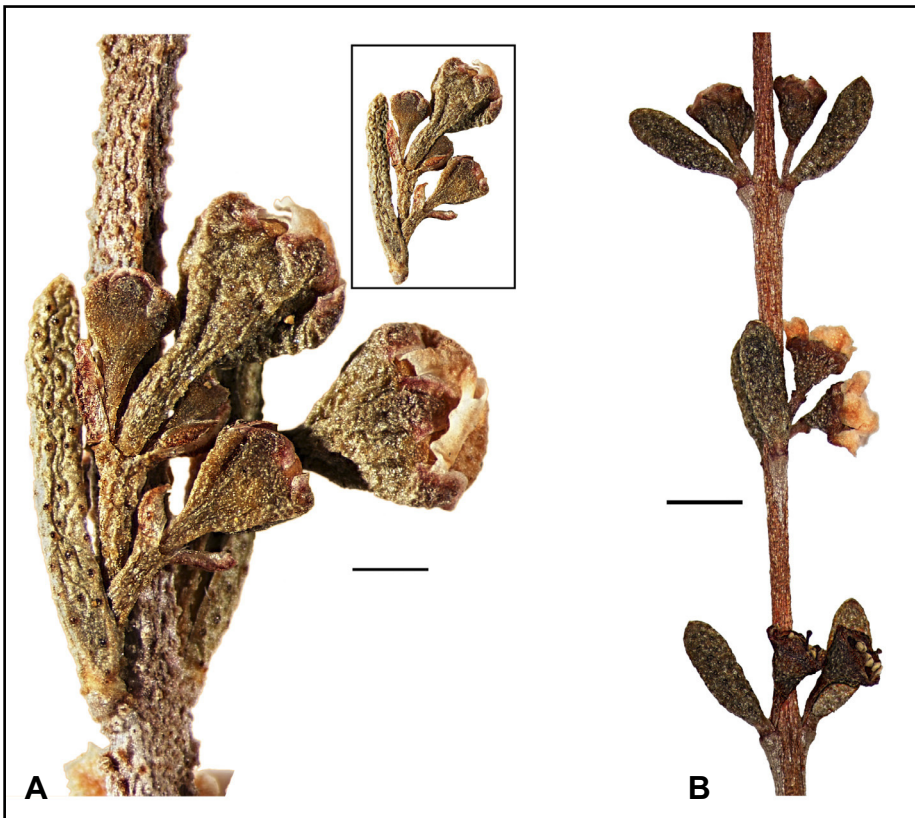


Figure 2. Flowering stems. A – crown-like outgrowths and a multi-flowered axil of *Astartea muricata*; B – part of branchlet with buds, flowers and fruits of *A. transversa*. Scale bars = 1 mm. Images from R.J. Cranfield 4506 (A) and E.A. Griffin 4073 (B). Prepared by A.R. Williams.

can be quite broad and continue to enclose older buds (Figure 3H). If the bracteoles separate from one another without falling they may occasionally persist after anthesis.

Flowers

Merosity. All species have primarily 5-merous flowers, although occasional 4-merous flowers may be produced, sometimes apparently in response to stress; these tend to be the first or last flowers opening on an individual plant. In large-flowered species there may also be occasional 6-merous flowers. In 5-merous buds, the petals overlie one another in a layer five thick above the nectariferous ovary summit. The innermost petal is the most crinkled by the anthers or stamen fascicles it covers and the outermost one smoothest, a difference that is visible in the opened flowers (Figure 1C).

Size. Flowers range from moderately large in relation to other Chamelaucieae down to the ‘excessive minuteness of the flowers’ noted by Bentham (1867: 79) in *A. arbuscula*. Flowers of *A. arbuscula* are 1.5–2 mm in diameter, with petals only 0.4–0.6 mm long, an exceptionally small size for Myrtaceae. The largest flowers occur in two species that grow on granite outcrops, with the petals of *A. granitica* Rye & Trudgen (Figure 1D) 4–6 mm long, ten times larger than those of *A. arbuscula*, and the flowers of *A. middletonii* Rye up to 15 mm in diameter.

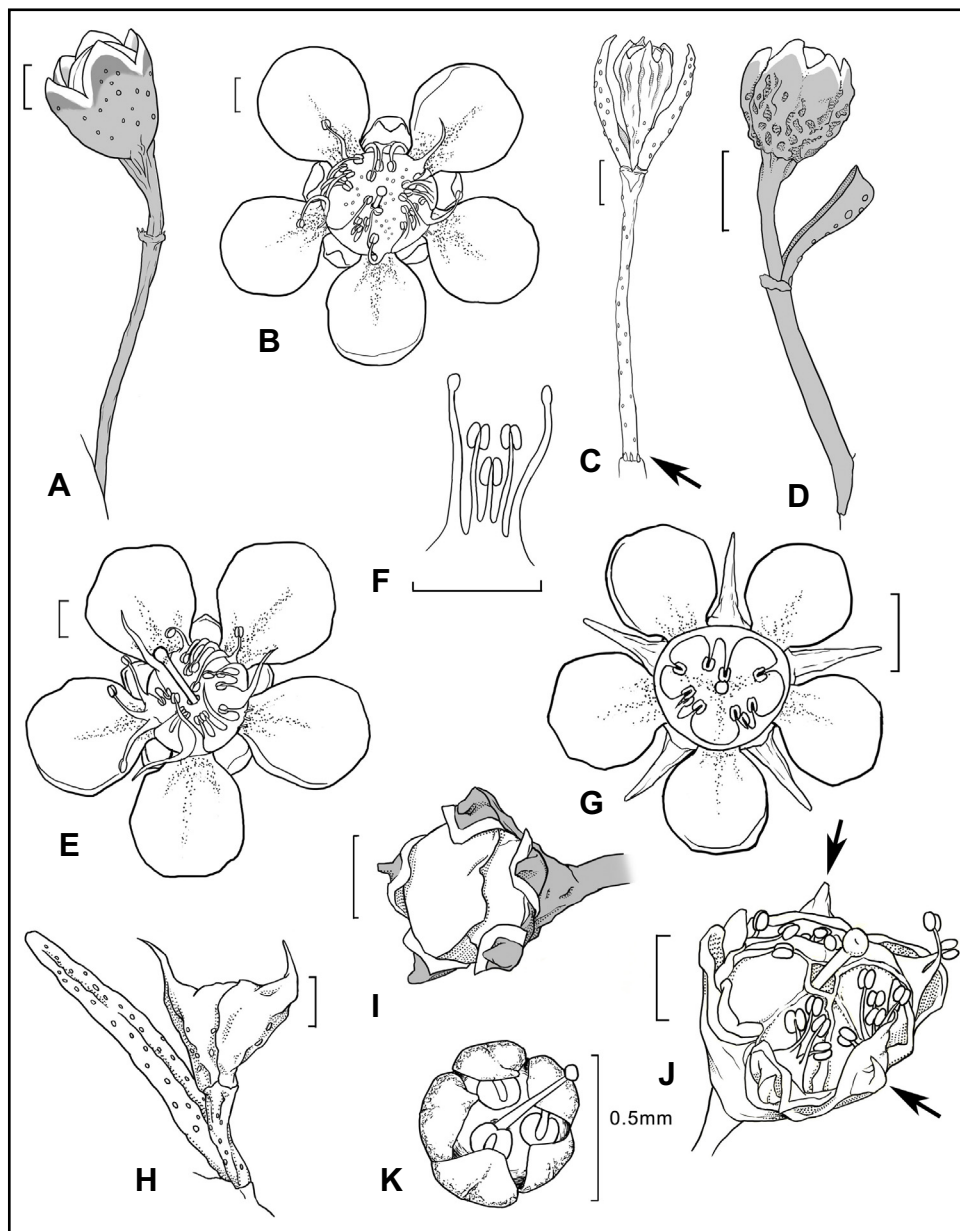


Figure 3. Illustrations of *Astartea* buds, flowers and fruits. A, B. *A. cicatricosa*. A – flower bud after bracteoles have been shed; B – flower; C – *A. decemcostata* flower bud subtended by two bracteoles, with stipules (arrowed) at the junction of the peduncle and the stem (the subtending leaf has been removed); D–F. *A. montana*. D – flower bud with only one bracteole persisting; E – flower; F – fascicle with lateral staminodes; G – *A. onycis* flower; H–J. *A. schaueri*. H – peduncle, subtending leaf and bracteoles enclosing bud; I – flower bud; J – fruit (with outer horns arrowed); K – *A. transversa*, top view of fruit with three stamens. Scale bars = 1 mm (A–J); 0.5 mm (K). Drawings from M. Bennett 25 (A, B); M. Hislop 2888, S. Barrett & J.A. Cochrane (C); G.J. Keighery 2595 (D, F); M. Hislop 2523 (E); G.J. Keighery 13464 (G); A.R. Annels 995 (H); B.G. Hammersley 3245 (I); R. Davis 4791 (J) and G.J. Keighery 8398 (K). Prepared by L.N. Rye.

Colour. Flower colour shows relatively little variation within the genus, varying in most species either from white to pale pink or from pale pink to medium pink, so that most species can be categorised as predominantly white-flowered or predominantly pink-flowered. The only variation from this, a very deep pink colour, is found in the very small flowers of some specimens of *A. arbuscula* and *A. arbuscula* × *corniculata*.

Hypanthium. Hypanthium texture (in the dried state of herbarium specimens) varies from fairly smooth but with slightly protruding oil glands (Figure 3A) to rugosely reticulate-pitted (Figure 3D) or ribbed (Figure 3C).

Sepals and petals. Sepals have a petaline margin surrounding the herbaceous base, which varies from smooth (Figure 3A) to deeply ridged, with the ridge often protruding into a short (Figure 3I) or long (Figure 3G) horn. Sepals tend to be more erect than the petals, which open widely at anthesis (e.g. Figure 3B), although the horn (when present) is sometimes widely spreading (Figure 3G). The partially herbaceous sepals persist in fruit whereas the more delicate petals are shed before the fruit reaches maturity.

Androecium

Ontogeny. Carragan and Drinnan (2000) showed that the stamens of one *Astartea* species* are initiated opposite the petals, but in later development form a ring and, later still, become concentrated opposite the sepals. A similar developmental sequence was found in *Hypocalymma cordifolium* (Lehm.) Schauer, but stopping one stage earlier in that species so that the stamens remain in a uniform ring.

Stamen number. Stamen numbers are lowest (3–5 per flower) in *A. transversa* and highest (37–60 per flower) in *A. middletonii*. Infra-specific variation in stamen number is often considerable, with differences occurring not only between populations and individuals of each population, but also between flowers on each plant and between sepals in the same flower (e.g. Figure 3G).

Stamen arrangement. Where stamen number is only three to five per flower, each stamen is solitary, situated opposite the centre of a sepal, and well separated from adjacent stamens (see the 3-staminate fruit in Figure 3K). Most species of *Astartea* have more numerous stamens with some (Figure 3G) or all of them (Rye 1987: Figure 140C) united into fascicles opposite each sepal. If there are only two or three stamens opposite a sepal, they do not necessarily form an obvious fascicle; if they are well separated they are either completely free or only shortly united. Whether or not these few stamens form a fascicle may vary between flowers on the same plant and also between sepals on the same flower. Whenever there are four or more stamens opposite a sepal, they always form an obvious fascicle.

Where stamen numbers are high in *Astartea*, especially when 35–60, the stamens are arranged in more than one series, but in species with low numbers of stamens the inner series is absent or only slightly developed. Stamens of the inner series are noticeably shorter than adjacent stamens of the outer series. Where stamen numbers are high there is a tendency for a solitary stamen to be present opposite some or all of the petals in addition to the antisepalous fascicles. In this case there may be a slight connection

*given as *A. heteranthera* = *Cyathostemon heterantherus* (C.A.Gardner) Rye & Trudgen, but probably *A. scoparia* Schauer judging from the images and the fact that this species is described as having 30 stamens.

also between the antisepalous fascicles and the solitary antipetalous stamens, resulting in a complete ring of stamens fused at the base (Figure 3E).

Staminode number and arrangement. Whereas most *Astartea* species lack staminodes or only occasionally produce a few of them, *A. fascicularis* and *A. montana* Rye have up to ten staminodes per flower. Staminodes occur on the margins of antisepalous fascicles or directly opposite petals.

Fascicle structure. Each antisepalous fascicle, or each series within the fascicle, has the longest filaments towards the outside, i.e. closest to the petals, and antipetalous stamens are also long. Usually the outermost filaments of each fascicle are united for the shortest distance, as shown for the marginal staminodes in Figure 3F, with the united part of the fascicle deepest at the centre. Occasionally, however, the fascicle has a central cleft (Figure 3B, arrowed).

Anthers. Anthers have two parallel loculi and a free connective gland in a subterminal, dorsal position. The base of the anther is attached to the filament and each loculus releases its pollen through a longitudinal slit. Apart from variation in the orientation of the loculi from introrse to latrorse, the anther morphology in *Astartea* is fairly consistent.

Gynoecium

Number of loculi. In species with a normally 3-locular ovary, there are often a few flowers that have a 2- or 4-locular ovary. Only a few species are characteristically 2-locular; in these one of the loculi may be reduced and sterile so that the ovary is functionally 1-locular.

Orientation and symmetry. Most *Astartea* species, like most other members of the tribe Chamelaucieae, have radially symmetrical flowers with no obvious orientation of the ovary loculi in relation to the stem. An exception is *A. arbuscula*, which has a functional, abaxial loculus and a greatly reduced, non-functional, adaxial loculus. The bilaterally symmetrical flowers have a petal directly opposite the axis (i.e. adaxial) and a sepal on the abaxial side. The opposite orientation, i.e. with a sepal directly opposite the axis, is found in *Corynanthera* J.W.Green and in a few species of *Micromyrtus* Benth. that have a very compressed hypanthium. Owing to the unequal development of the two loculi in *A. arbuscula*, the style is off-set towards the adaxial side of the flower.

Ovules. Ovule number varies from one per flower in *A. arbuscula* to a maximum of about 60 in *A. fascicularis*. Each placenta of the latter species has 14–23 ovules arranged in two close rows along its length and radiating at both ends.

Style. The style is much longer in fruit (e.g. Figure 3K) than when the flowers are newly opened (Figure 3B,G). It is dark red at maturity on the part that is exposed to sunlight but much paler on the enclosed basal part. The base of the style is usually in a deep cylindrical depression that reaches the level of the placentas. The depression is reduced in 2-locular ovaries that have one loculus abortive, although the base of the style still reaches the level of the single functional placenta, which is tilted towards the top of the ovary.

Stigma. In flowers with a 3-locular ovary, the peltate stigma is more or less circular from top view, although it is slightly divided into three regions (Rye 1987: Figure 140F).

Fruiting characters

Fruits. In most species the fruits are predominantly 2- or 3-valvate and about half-inferior (see the 3-valvate fruit in Figure 3J). The extreme base of the style may become split into three after the fruit opens fully, having been torn by the three separating parts. Indehiscent fruits, like the one illustrated in Figure 3K, are two-thirds to three-quarters inferior. Seed numbers vary from one per fruit, which is a common occurrence when the fruit is indehiscent, to many per fruit, with up to five or rarely more per loculus.

Typical seeds. *Astartea* seeds are small, with an average length of about 1 mm. The embryo is enlarged at the proximal end and enclosed within a body of corresponding shape (normally irregularly ovoid as shown in Figure 4A,B,D,F,G). Where seeds are relatively numerous, as is common in *A. fascicularis*, there is a tendency for those that are closely pressed against adjacent seeds to be flattened on their lateral surfaces, making them slightly faceted, although the free surfaces are still rounded. Towards the base of the inner surface there is a small hilum and above this is a slight to very obvious protrusion attached for its full length to the seed body. The inner protrusion increases the width of the distal end of the seed where its embryo and body are narrowest. The testa of the seed body is crustaceous but thin, and has a fairly smooth surface on which a reticulate pattern of cells is visible. The inner protrusion is usually fairly obvious, contrasting in its texture and/or colour from the smooth, uniformly pale or mottled body of the seed. Typical *Astartea* seeds, as described here, occur in well over half of the species. Deviations from these in seed shape, colour and testa thickness are correlated with the habitat or reproductive strategy of the species.

Thick-coated seeds. Seeds with an unusually thick testa occur in the *A. aspera* group, which extends into relatively dry habitats. These seeds can be distinguished from those of other members of the genus by their reticulate-pitted (Figure 4A; see also Rye & Trudgen 2008: Figure 3A) or colliculate testa. In most members of this group the testa is uniformly dark red or red-brown and contrasts strikingly with the white or off-white protrusion on the inner surface. Fruits in this species group also tend to have thicker walls than those found in other members of the genus.

Thin-coated seeds. Throughout the tribe Chamelaucieae, it is usual for seeds of indehiscent fruits to have a very thin testa, and there may also be a modification of the seed shape and orientation. *Astartea transversa* produces a single, horizontal seed, wrapped around its attachment point (Figure 4I). The shape of the seed in this case is almost reniform but with one end distinctly smaller than the other. In *A. arbuscula* the solitary seed is more erect and closer to the normal shape for *Astartea*, but its testa is membranous.

Seed colour. *Astartea* seeds vary from uniformly off-white to golden brown through variegated colouring to uniformly dark red or red-brown (as noted above for some thick-coated seeds). Mottled seeds may show a large degree of infra-specific variation in their markings (Figure 4F,G), often including some obvious variation within each fruit.

Chaff. Chaff pieces are often very compressed or shrivelled and uniformly dark-coloured (Figure 4E,H), in striking contrast to the plump seeds (Figure 4D,F,G). In *A. cicatricosa* Rye & Trudgen the chaff pieces (Figure 4C) have a more seed-like appearance, but are colliculate rather than reticulate-pitted and lack the strongly contrasting, whitish inner protrusion found on the seeds (Figure 4B).

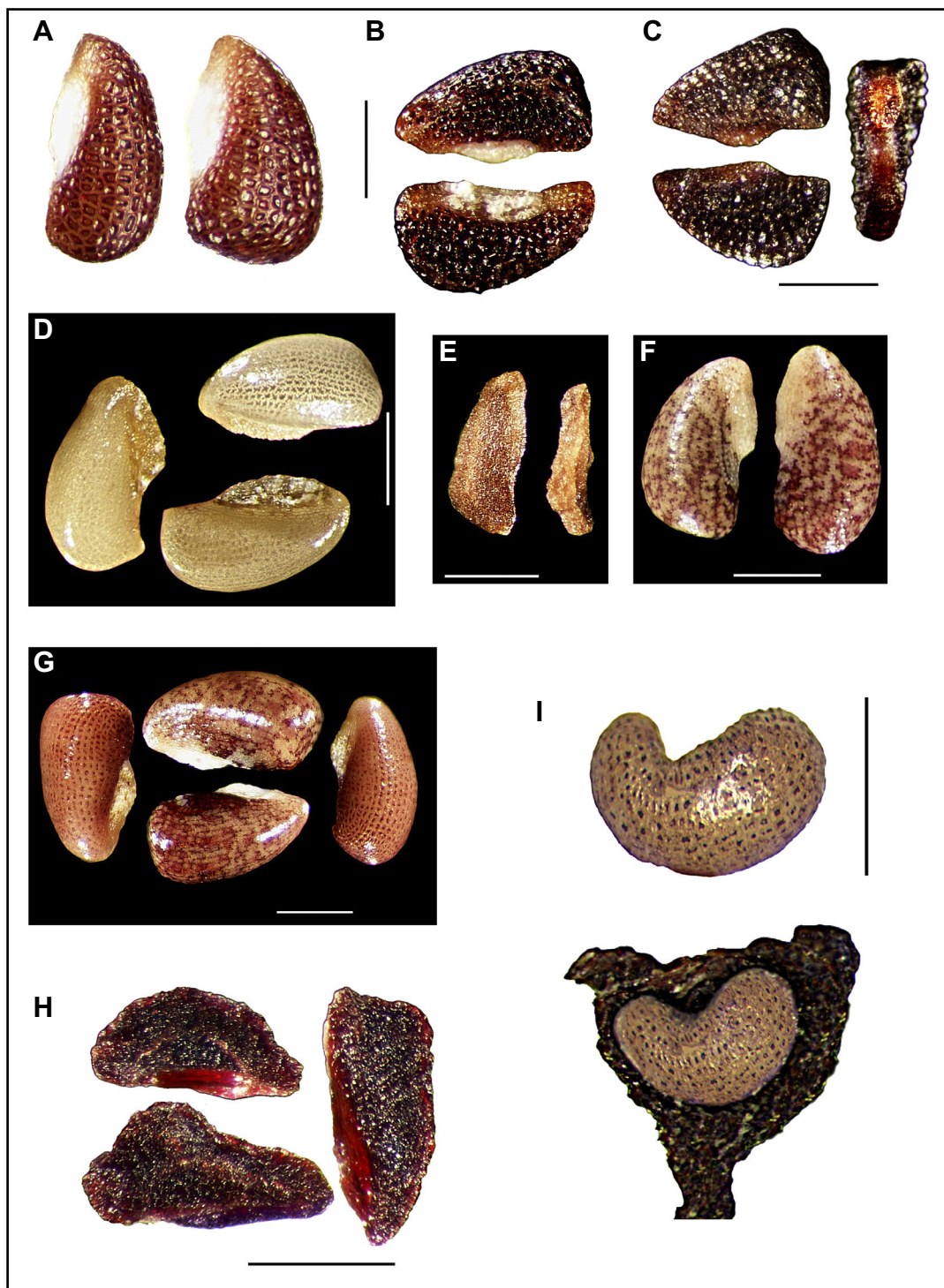


Figure 4. *Astartea* seeds and chaff. A – seeds of *A. aspera*; B – seeds of *A. cicatricosa*; C – chaff of *A. cicatricosa*; D – seeds of *A. granitica*; E – chaff of *A. granitica*; F – seeds of varied size in *A. schaueri*; G – seeds of varied colour in *A. schaueri*; H – chaff of *A. schaueri*; I – seed of *A. transversa*, also shown below still embedded in the indehiscent fruit. Scale bars = 0.5 mm. Images from B.E. Hall 30 A (A); A. Strid 21898 (B, C); A.R. Annels 5645 (D, E); R. Davis 4791 (F, H); R.W. Hearn ARA 5714 (G) and E.A. Griffin 4073 (I). Prepared by A.R. Williams.

Distribution and phenology

Astartea is restricted to the south-west of Western Australia (Figure 5A), with its peak concentration in the region of high rainfall and relatively low temperature along the south coast between Northcliffe and Albany. It extends north to the Moore River, west to Augusta and east to Cape Arid National Park and Middle Island, but only extends as far inland as the Dumbleyung area.

Habitat

Astartea species occur in damp habitats associated with depressions, watercourses and rock formations such as granite outcrops. Most species are predominantly associated with swamps and watercourses, including one (*A. leptophylla* Schauer) that is confined to the banks of seasonally fast-flowing watercourses. Three members of the genus, *A. fascicularis*, *A. granitica* and *A. middletonii*, appear to be restricted to granitic habitats, while *A. montana* and *A. decemcostata* Rye occur in other kinds of rocky habitats in the Stirling and Barren Ranges respectively. The soils of these damp habitats tend to have a high organic content.

The riverine species *A. leptophylla* has all the typical morphological and reproductive traits (listed below) of a rheophyte. Van Steenis (1981: 3) defines rheophytes as plants that are found in ‘the beds of swift-running streams and rivers and grow there up to flood-level, but not beyond the reach of regularly occurring flash floods’. Rheophytes are usually glabrous and are characterised by their anchorage and toughness, establishment from seed, but often also with vegetative reproduction, and their densely arranged, narrow leaves.

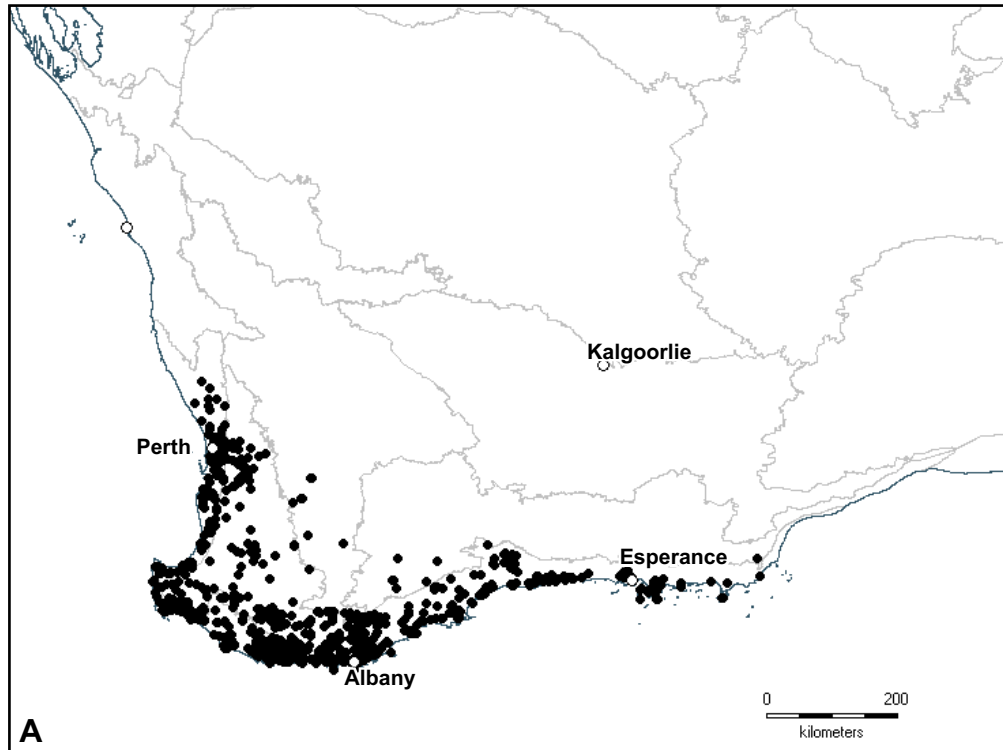
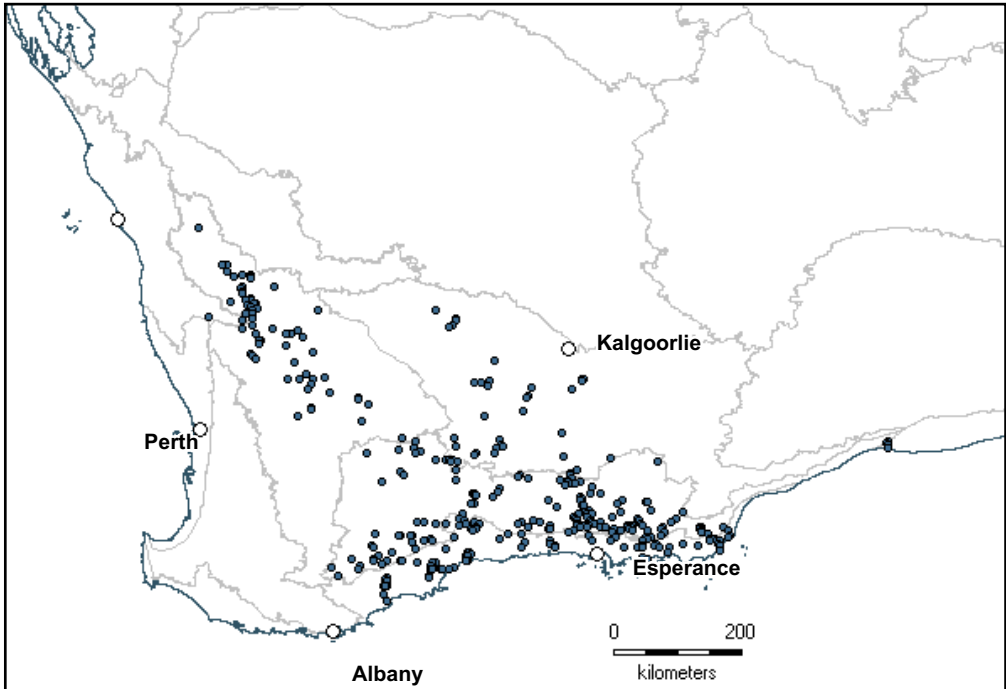
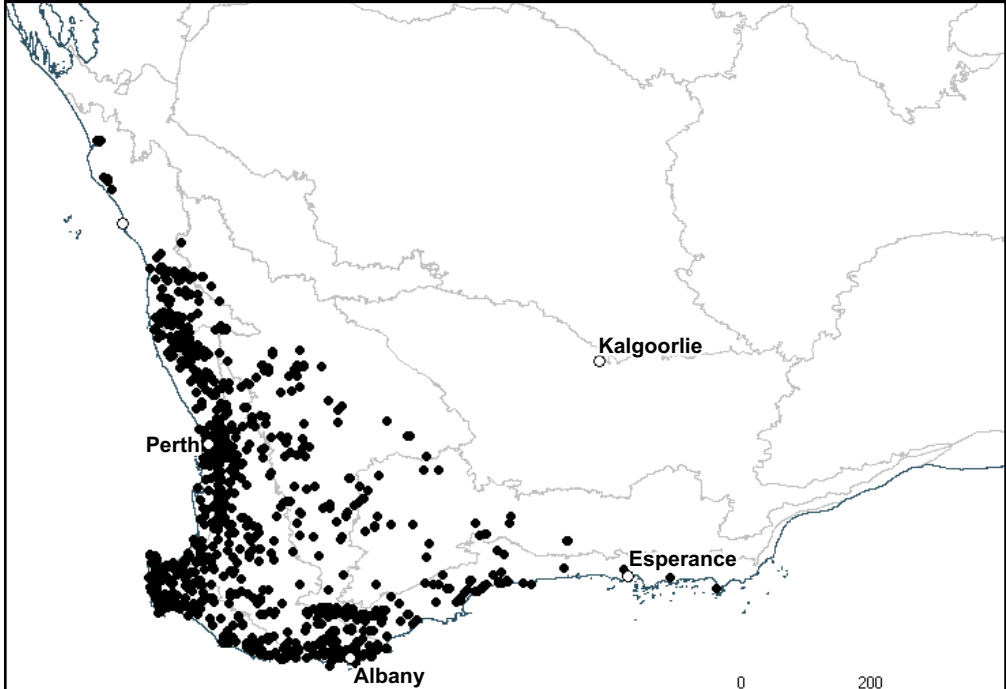


Figure 5. Generic distributions. A – *Astartea* (●); B – *Cyathostemon* (●); C – *Hypocalymma* (●) (facing page).



B



C

Phenology

A possible consequence of the association of *Astartea* species with damp environments is their tendency to flower during the dry season. Most species flower during summer, often peaking in January, although a few flower predominantly in spring and early summer. Fruits are produced quickly following flowering; as flowering usually continues for several weeks, the stems may show a progression from young buds through to fruits (see Figure 2B). In most taxa, capsules remain attached to the plant long after they have shed all or most of their seeds, and a few may still remain on the stems during the following flowering season. Several taxa, however, produce indehiscent fruits, which are shed from the plant together with the enclosed seeds.

Insect associations

Many insect groups are associated with *Astartea* species, some benefiting the plants and others harmful, the latter kind utilising the sap or organs of the plants for a food source. Beneficial insects include pollinators and the predators or parasites of the harmful insects. As discussed under *Seed adaptations* below, insects might also play a role in seed dispersal. Of greatest interest are those insects that display host-specificity to the genus *Astartea*, or to its generic grouping, or to the tribe Chamelaucieae as a whole.

Blossom feeders

Astartea species are predominantly insect-pollinated. Keighery (1982) considered pollination by native bees to be of greatest importance in *Astartea*, with beetles and flies also contributing. Houston (2000) listed 11 native bee species in five genera as visitors to *Astartea* flowers. Brown *et al.* (1997) listed one jewel beetle, *Themognatha mitchelli*, as a visitor to *Astartea* flowers; jewel beetles were commonly observed in the current study, for example on *A. affinis* (Figure 1B).

Adult males of the wingless fly species *Badisis ambulans*, whose larvae inhabit the pitchers of the Albany Pitcher Plant (*Cephalotus follicularis*), ‘forage on *Astartea fascicularis* (Myrtaceae) blossom during the day’ (Yeates 1992: 423). They mimic a group of ants, belonging to the genus *Iridomyrex*, which are common in the areas where the fly species occurs. Probably the most common insect visitors to the flowers observed in the current study were ants, but whether these or the ant-like flies play any significant role in pollination is unknown. Interestingly, the only species of *Astartea* recorded from the area close to Pemberton where Yeates collected male *Badisis* flies is *A. laricifolia* and its main area of distribution coincides very well with the distribution of *Cephalotus*, raising the possibility that *A. laricifolia* is the primary host species for these adult flies. Certainly *A. fascicularis s. str.* is not a contender as it occurs well outside the geographic range of *Cephalotus*.

As *Astartea* species tend to flower in summer at a time when most other kinds of angiosperms are relatively inactive, they are a major source of nutrition for a wide range of nectar-feeding insects at that time of year. *Astartea laricifolia* is particularly floriferous, and in the early morning its flowers attract a horde of insects of very varied kinds. This may be one reason for a high success rate of pollination in *Astartea* (see below under *Chromosome numbers and breeding systems*).

Sap Feeders

Most of the insects that feed on plant sap are bugs (order Hemiptera), including the extremely large

family Miridae. The south-western Australian Mirid genus *Myrtlemiris* appears to have most of its species confined to host genera in the tribe Chamelaucieae (Cheng *et al.* 2012). One species, *M. astartephila*, is currently known from a single *Astartea* host species. More field work is needed to determine the degree of host-specificity of this insect, as most *Myrtlemiris* species have been recorded from more than one host genus within the tribe.

Larvae of Felt Scales (family Eriococcidae) can occur in large numbers on *Astartea* stems. These insects belong to the small genus *Callococcus* (L. Cook pers. comm.), whose type species, *C. pulchellus*, was named from a host species in the related genus *Hypocalymma*. *Callococcus* infests most species of *Astartea*, having been recorded so far in *A. affinis* (F. Hort 3155 & J. Hort), *A. arbuscula* (e.g. A.R. Annels 5295 & R.W. Hearn, N. Gibson & M. Lyons 103), *A. aspera* (e.g. R. Davis 4961), *A. cicatricosa* (e.g. L. Ang & S. Kern 10358), *A. corniculata* Schauer (B.L. Rye 221260), *A. decemcostata* (M. Hislop 2885, S. Barrett & J.A. Cochrane), *A. glomerulosa* (e.g. R.J. Cranfield & B.G. Ward WFM 285), *A. laricifolia* (D. Rooks 124), *A. leptophylla* (e.g. J. Forrest s.n. MEL 76237), *A. montana* (e.g. B.L. Rye 221263), *A. schaueri* (e.g. B.L. Rye 221246), *A. reticulata* Rye (e.g. G. Craig 8004) and *A. scoparia* (e.g. M.E. Trudgen 20428 & R. Archer).

The *Callococcus* larvae (Figure 6) occur at nodes on the stems, often with several at a single node, and there is a marked difference between the male and female larvae. Females have a shell-like cover that is whitish throughout, although it may become greyish or brownish with age. At maturity, the shell is very thick and appears somewhat crustaceous (Figure 6A). It is usually longitudinally patterned, having two broad, parallel furrows (see right side of Figure 6B). In some cases the shell is shorter and transversely furrowed but whether this represents a different species or infraspecific variant of *Callococcus* is not yet known. Male larvae form smaller, nondescript, felted covers (left side of Figure 6B).

To date no *Callococcus* infestations have been found on any specimens of *A. zephyra*, not even at a locality (B.L. Rye 241204 & 241205, F. Hort & J. Hort) where it occurred intermixed with a highly infested population of *Hypocalymma angustifolium* Endl. (B.L. Rye 241206, F. Hort & J. Hort). This suggests either that *A. zephyra* is not susceptible to *Callococcus* or that the particular species or variant of *Callococcus* present was host-specific to *Hypocalymma*.

Within the tribe Chamelaucieae, *Astartea*, *Cyathostemon* and *Hypocalymma* are evidently the only host genera for *Callococcus*, based on an extensive survey of PERTH herbarium specimens of all genera of the tribe. *Callococcus* has been found across most of the combined geographic range of these three closely related plant genera (Figure 5) in the south-west of Western Australia and has evidently co-evolved with them. A quite distinct type of *Callococcus*, in which the larvae produce galls rather than scales, occurs on *Leptospermum* Forst. & G.Forst. of the related tribe Leptospermeae DC.

More numerous species of sap-utilising insects have larvae attached to leaves rather than stems. Some species or genera might be specific in their host plants, but a specialised study of each insect group would be needed to investigate this possibility. Several kinds of black scales, probably formed by whitefly larvae (family Aleyrodidae), have been recorded on *Astartea*, for example on *A. corniculata* (e.g. E.J. Croxford 918), *A. muricata* (F. & J. Hort 2497) and *A. scoparia* (R.J. Cranfield 22509). This group of insects appears to include species that are host-specific for certain members of the Chamelaucieae, but no evidence has been found in the current study to indicate any being host-specific to *Astartea*.

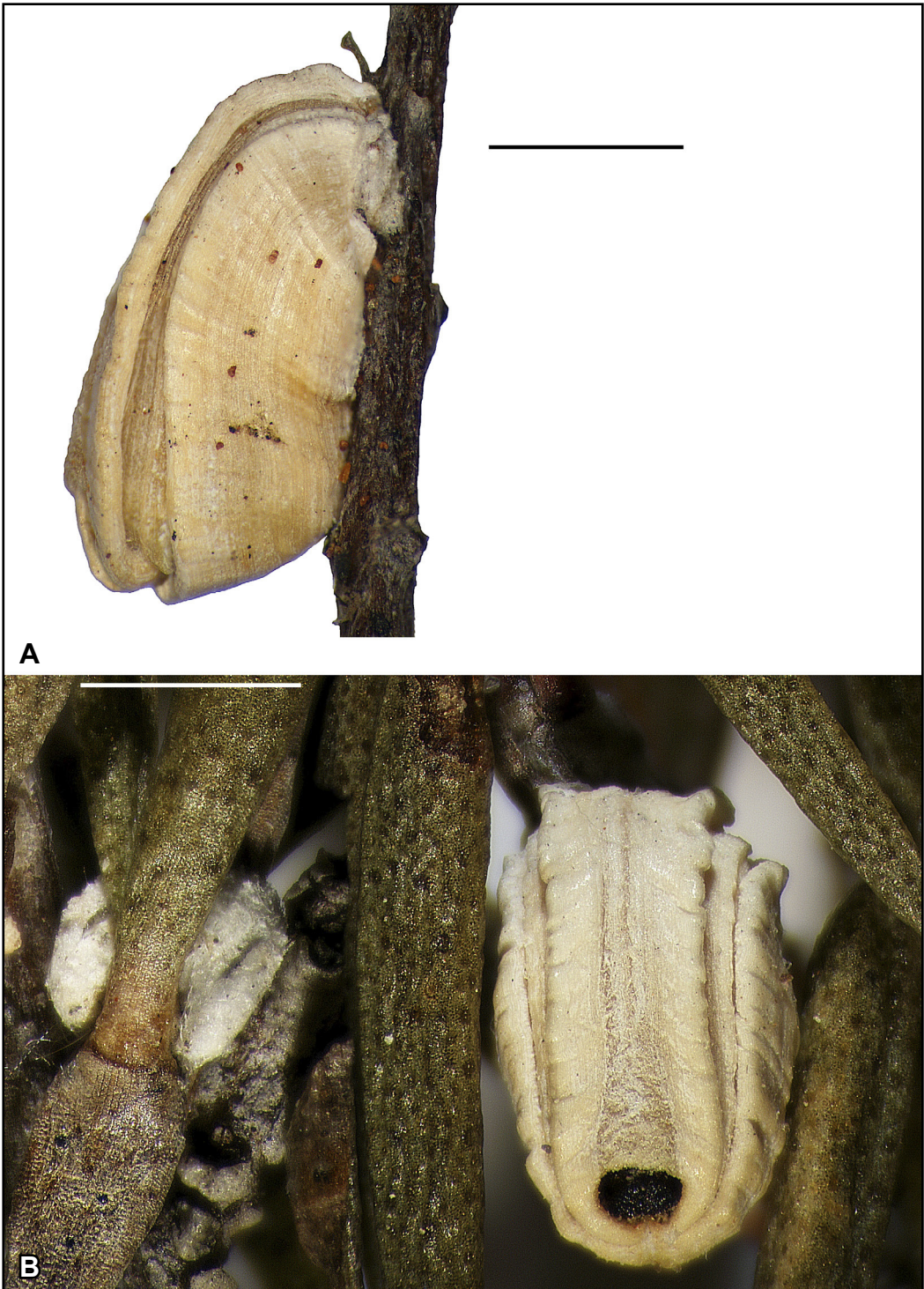


Figure 6. *Callococcus*. A – female scale on *Astartea arbuscula*; B – two male scales (left) and a female scale (right) on *Astartea scoparia*. Scale bars = 1 mm. Images from B.L. Rye 221237 & R.W. Hearn (A) and M.E. Trudgen 20428 & R. Archer (B). Prepared by A.R. Williams.

Galls

Various kinds of rounded galls, formed from flowers or other organs, have been observed on most species of *Astartea*. Also common are galled young shoots with abnormally broad leaves that are appressed and imbricate (Figure 1F). The insects or other factors responsible for inducing these galls have not been identified, although it is likely that galls commonly contain wasp larvae, as has been established in the genus *Enekbatus* Trudgen & Rye (Trudgen & Rye 2010).

Other aspects of the biology of *Astartea*

Growth forms

Most species of *Astartea* produce below-ground lignotubers and have three to numerous main stems separated at ground level. They resprout readily after their aerial parts have been destroyed by fire or other factors (Figure 1A). Lignotubers may also confer some degree of protection against the root-infecting fungus *Phytophthora*, with non-lignotuberous species such as *A. granitica* being more susceptible (R. Hearn pers. comm.). Seedlings in lignotuberous species are often rare, except where disturbance has resulted in open ground, as on road verges.

Obligate-seeder species lack a lignotuber but produce numerous seedlings following the death of the mature plants by fire, drought or other causes. Initially single-stemmed at the base, they may either remain with this habit or produce several lateral main branches just above ground level, and the base may become enlarged. The multi-branched growth form is common in many shrub genera of Myrtaceae, such as *Thryptomene* Endl., and possibly confers greater fire-resistance than that with the single stem continuing for some height above the ground.

Differences in reproductive success have been observed in two gardens at Manjimup (R. Hearn pers. comm.), where the single-stemmed species *A. granitica* produced self-sown seedlings but several lignotuberous species did not. A detailed study of *A. granitica* [as *Astartea* sp.] by Hutchison (1997) has provided evidence that fire assists in breaking seed dormancy, with germination rates of less than 15% increased to over 70% by the application of smoke-treated water.

A third growth form produced by suckering is commonly found in *A. leptophylla* along river banks. The single main stem of this species is commonly rendered more or less horizontal following subsidence of the river bank; from this a row of connected, but individually rooted, erect stems is produced. Suckering is also found in the *A. aspera* group when plants occur on river banks, although in this case forming a lower, more spreading habit. Other species may also be capable of reproducing in this way following various kinds of disturbance, or at least of forming a row of unrooted erect stems along a fallen main stem lying above the ground, as has been observed in *A. laricifolia*. *Astartea laricifolia* may be single- or multi-stemmed, perhaps developing a lignotuber when conditions favour this growth form.

Infra-specific variation

Some taxa show a remarkable degree of variation within some populations. Characters that vary within populations of *A. laricifolia* include habit (see above) and the degree of development of wings on the young stems. Some *A. affinis* populations show great variation in flower size or the degree of horning on the sepals.

Much of the variation observed within species is seasonal or caused by variation from one year to the next in the amount of rainfall, occurrence of fires, etc. There is also considerable variation within and between populations owing to genetic and microhabitat differences at any given time. All of these sources of variation contribute to the taxonomic difficulty of the genus.

Over summer the plants may be under considerable stress as their winter-wet habitats dry out. An early response to this is the shedding of the lower leaves, which often first turn yellow or red. Failure of seed development, perhaps as a result of excessive water stress in a bad season, was observed in 2003 in a population of the lignotuberous species *A. middletonii*. This species is restricted to granite outcrops, where the effects of drought may be more extreme than for plants occurring along watercourses or associated with other wetlands.

Chromosome numbers and breeding systems

The base chromosome number for the genus is evidently 11, the same as for the family as a whole, although only one species has been sampled so far. That taxon, a member of the *A. aspera* group, was tetraploid, having 22 chromosomes (Rye 1979).

As in many other Myrtaceae, *Astartea* has protandrous flowers, increasing the chances of cross-pollination. Well exposed nectar and pollen attracts a large number of ants, bees, wasps, beetles, flies and other insects to the flowers. The success of this relatively unspecialised pollination strategy is evident from the high proportion of seed set in most cases.

Seed adaptations

Seeds are generally smaller in *Astartea* than in the related genera *Cyathostemon* and *Hypocalymma*, and the seed coat is usually thinner and less crustaceous, although it is quite well developed in the *A. aspera* group. These seed characters are presumably an adaptation to the moist but relatively exposed sites favoured by most species of *Astartea*. The *A. aspera* group, with relatively thick-walled capsules containing relatively large (up to 1.3 mm long) seeds with a thick testa, extends further inland than other species groups, although still restricted to moist habitats within this drier climatic region. The smallest seeds, down to 0.6 or rarely 0.5 mm long, tend to occur in the species occurring in the most humid environments, at least in comparison with their closest relatives.

Hutchison (1997: 36, Figure 9A) was the first to document the existence of a structure, which he described as 'a soft fleshy elaiosome', on the inner surface of *Astartea* seeds. In his study of *A. granitica* [as *Astartea* sp.], Hutchison suggested that the relatively delicate seeds would not survive the extreme summer conditions on a granite outcrop unless taken below ground by ants. The presumed elaiosome, referred to in the morphology section as the 'inner protrusion', is succulent on young seeds and is slightly to markedly different in colour from the remainder of the seed. No studies have been conducted to test the theory that this structure does function as an elaiosome in *Astartea*, but its size and nature in some species such as *A. granitica* suggest that it would be attractive to ants. Similar seed morphology is found in *Cyathostemon* and *Hypocalymma* species, and ants have been observed collecting seeds from two species of the latter genus (G. Keighery pers. comm.).

Being so firmly attached to the seed body, the inner protrusion would not be easy to dislodge, unlike the situation in genera such as *Euryomyrtus* Schauer and *Rinzia* Schauer that have an aril only narrowly attached to the seed body; in the latter genera ants might be able to remove the elaiosome from the seed

body *in situ* rather than transporting the entire seed. Clearly, however, the inner protrusion does not always function as an elaiosome as it has been greatly reduced in size in some species of *Astartea*. Evidence that it is linked to seed dispersal in some way is the fact that it is most reduced in *Astartea* species that have indehiscent fruits.

Even when the protrusion is reduced in size, it could provide an easier point for ants to grasp than the smooth testa, so perhaps its function is primarily to improve the portability of the *Astartea* seeds rather than to provide nutrition. While the testa is usually too thin to prevent ants from gaining access to the embryo, the storage of seeds for later consumption in ant nests could have the benefit of preventing other granivores from eating the seeds and improve the likelihood of a few seeds surviving until conditions suit germination.

Among those species of *Astartea* with an indehiscent fruit, there are no obvious structures attached to the fruits that might assist with seed dispersal. However, indehiscent fruits are very small and single-seeded, and are still light enough for ant-dispersal to be a possibility.

Hybridisation

Many pairs of *Astartea* species have been observed growing in intermixed or adjacent stands in the wild, particularly along the south coast from the Walpole area to the Albany area. A similar situation exists in *Kunzea* Rchb. sect. *Zeanuk* Toelken (tribe Leptospermeae), which is also restricted to the wetter areas of the south-west and thrives in disturbed areas. Toelken (1996) reported that hybridisation was widespread in this group. Additional species were later named to replace some putative hybrids in this taxonomically difficult group (Toelken & Craig 2007), but hybrids are still considered to be present.

In the field, the most obvious differences between co-occurring species of *Astartea* are generally in their mature size and form, such as whether or not they develop a lignotuber, and in their flowering stage. Flower size and colour, leaf size and shape and other characters may also differ significantly between two taxa at the same locality and there are often differences in microhabitats. Co-occurrence of species is mostly observed in swampy locations, with some species occurring in the centre of the swamps and others restricted to somewhat drier microhabitats around the margins. Those from the driest habitats tend to flower earliest, beginning in late spring, while those from the dampest habitats often do not flower until mid-summer. This reduces the opportunities for inter-specific cross-pollination. However, a few apparent cases of hybridisation are noted, and one presumed hybrid is fully described in this paper.

A cultivar known as *Astartea* ‘Winter Pink’ arose in cultivation by selection from hybrid seedlings of the plant with the greatest intensity of pink colour in its flowers (APNI 2013), the parents reputed to be *A. clavulata* Turcz. [= *A. aspera*] and *A. astarteoides* (Benth.) Rye. Although the identities of the parents are far from certain, a combination of one parent from the *A. aspera* species group and one from the *A. montana* group may well have been involved in view of the small size of the plant and its pink flower colour. Both species groups tend to flower primarily in spring rather than summer, a tendency that may have combined to produce an even earlier flowering time in the hybrid. No natural taxa within the genus are known to flower primarily during winter as suggested by the name of this hybrid cultivar.

Reproduction and conservation

As a general rule *Astartea* species reproduce readily, are abundant at most of their locations and readily colonise road verges and other open ground. Some taxa, however, are at risk because they are geographically restricted. Some populations may be at risk from increasing salinity or weed infestation of their winter-wet habitats, especially in areas surrounded by land cleared for farming or urban developments.

Astartea species are easy to propagate by seed or cuttings, and thrive under cultivation in south-western Australia, requiring no watering when grown in the more humid areas of the region. They may tend to have greater shoot: root ratios than most species from similar habitats. In a study of swamp communities near Gnangara, Dodd *et al.* (1984) noted that '*Astartea fascicularis*' [probably actually *A. scoparia*] had a root: shoot ratio in excess of 1 and was able to resprout from its root stock, whereas most species (from other genera) with a similar type of rooting pattern had a much lower root: shoot ratio and were much more susceptible to fires.

This ease of reproduction seems appropriate in a genus named after a goddess of fertility, and gives *Astartea* species the potential to become weeds. A few taxa have been recorded as starting to naturalise in south-eastern Australia (Richardson *et al.* 2006) or as having escaped from cultivation in New Zealand (de Lange *et al.* 2005).

Generic affinities and delimitation

As explained in the introduction, the delimitation of *Astartea* accepted here is that used in early publications from De Candolle (1828) to Turczaninow (1852). Later, beginning with Mueller's (1859, 1860) papers, the delimitation of the genus was confused both by the inclusion of atypical species and by the exclusion of species with very low stamen numbers. Most of the atypical species, including six that are currently known by informal names under *Astartea* on *FloraBase* (Western Australian Herbarium 1998–), are now considered to belong to the genus *Cyathostemon*, and two other species belong to *Seorsus*.

The newly segregated genus *Seorsus* has a very different distribution pattern (Rye & Trudgen 2008: Figure 4) from *Astartea* and differs in many morphological characters, particularly in its more faceted seeds and distinctive anther morphology (see Rye & Trudgen 2008 for a full discussion of the degree of their relationship and the similarities and differences between the two genera).

Evidence for affinities between *Astartea*, *Cyathostemon* and *Hypocalymma*

A strongly supported clade comprising *Astartea*, *Cyathostemon* and *Hypocalymma* has been obtained in molecular studies (Lam *et al.* 2002; Wilson *et al.* 2004) using four regions of chloroplast DNA (the *matK* gene, the 5' *trnK* intron, part of the *ndhF* gene and the *atpB-rbcL* intergenic spacer). The clade is also strongly supported in molecular analyses using the ETS nuclear ribosomal region (Wilson & Heslewood 2011; P. Wilson unpublished data).

As noted in the *Insect associations* section above, *Astartea*, *Cyathostemon* and *Hypocalymma* are host plants for *Callococcus*, an insect genus that is not known to infest any other members of the tribe Chamelaucieae, providing further evidence for the monophyly of the group.

Morphological similarities in the androecium and seeds indicate a very close relationship between *Astartea*, *Cyathostemon* and *Hypocalymma*. All genera have a variable number of stamens per flower, with the filaments variously united to some degree at the base into a ring or into fascicles; the only exception to this is seen in species of *Astartea* where the stamens are so reduced in number in that they are all free, but this is clearly a derived character (apomorphy). The three genera have more or less basifixed anthers with longitudinally dehiscent cells and a free connective gland. Their seeds are hard-coated, with little or no faceting, and they have a protrusion that is united for its whole length and width to the inner surface of the seed body.

As the three independent kinds of evidence, obtained from studies of morphology, molecular sequences and insect associations, concur, it can be concluded that the three genera *Astartea*, *Cyathostemon* and *Hypocalymma* form a monophyletic group.

Distinction of *Astartea*

Significant differences between *Astartea*, *Cyathostemon* and *Hypocalymma* in their morphology, chemistry and habitat preferences support the recognition of all three genera.

Stamens. Except for those taxa with very reduced stamen numbers, members of the genus *Astartea* s. str. have rarely been confused with the many genera that have been included in Bentham's (1867) very broad circumscription of *Baeckea*. This is because the arrangement of the stamens into fascicles opposite the sepals is a readily observable characteristic that is rare elsewhere in the family. A diagram of stamen arrangements in the Myrtaceae given by Johnson and Briggs (1984: Figure 8) includes one part (K) intended to represent the situation in *Astartea*, but is inaccurate in showing the longest stamens central rather than marginal (see Figure 3F). In genera with stamen fascicles opposite the petals, such as *Melaleuca*, the longest stamens do occur at the centre of the fascicle. This difference in the shape of antisepalous and antipetalous fascicles reflects a general tendency in Chamelaucieae, and in the family as a whole, for the longest stamens to be opposite the petals and the shortest ones opposite the sepals.

Hypocalymma species usually have numerous stamens united into a continuous ring, although very shallowly united fascicles occur in *H. scariosum* Schauer when its stamen numbers are low (12–15 per flower). *Cyathostemon* species never have discrete antisepalous fascicles, as in every case their stamens are all united into a complete ring. However, the stamens sometimes tend to form antisepalous groups, with the ring more deeply cut opposite the petals than elsewhere, as in *C. heterantherus*. In other species of *Cyathostemon*, such as *C. blackettii* (F.Muell.) Rye & Trudgen, the ring is either more irregular in shape or of more uniform depth throughout. Although *Astartea* has varied arrangements of its stamens (see *Morphology* section), all of them differ from the arrangements found in *Hypocalymma* and *Cyathostemon*. Even in the rare instances when its stamens are united into a complete circle, as sometimes occurs in *A. montana* and rarely in other species, the presence of antisepalous fascicles alternating with solitary antipetalous stamens is unlike anything found in the other two genera.

Seeds. *Astartea* seeds are smaller than those in *Cyathostemon* and most species of *Hypocalymma*. The seed testa in most species of *Astartea* is thin, with a finely reticulate, smooth surface rather than boldly reticulate-pitted as in *Hypocalymma* sect. *Hypocalymma* or smooth (but not so reticulate) to colliculate in *Cyathostemon* and *Hypocalymma* sect. *Cardiomyrtus* Schauer. An exception to this difference is the *A. aspera* group, which has a thicker testa, usually with a reticulate-pitted pattern more like that found in *Hypocalymma* sect. *Hypocalymma*, but the latter group has larger seeds with usually much deeper pits in the testa.

Other morphological differences. Some further morphological differences between the three genera are given in Rye and Trudgen (2008: Table 1) and the key on page 248 of that paper.

Distribution and phenology. All three genera occur only in south-western Australia (Figure 5), but unlike *Astartea*, *Cyathostemon* and *Hypocalymma* are not restricted to damp habitats; *Hypocalymma* extends much further north while *Cyathostemon* extends much further inland. *Astartea* is almost fully contained within the distribution of *Hypocalymma* but has a very different distribution pattern from that of *Cyathostemon*, overlapping only in the eastern part of its range from the Stirling Range area eastwards. Whereas most *Astartea* species flower in summer, most *Cyathostemon* and *Hypocalymma* species, even those associated with damp habitats within the range of *Astartea*, flower in spring.

DNA. In the molecular studies cited earlier, *Astartea s. str.* always had a very high degree of support as a monophyletic group. Although the chloroplast regions did not provide support for the recognition of the other two genera as they are currently defined, there was some support for all three genera in unpublished data for the ETS nuclear ribosomal region. If a broad circumscription of *Astartea* were to be adopted in the future, it would need to include both *Hypocalymma* and *Cyathostemon*, not just the latter as it has in the past.

Essential oils. In extracts taken from the leaves and terminal stems of two species of *Astartea*, Lowe *et al.* (2005) obtained high yields of essential oils, the three substances with the greatest concentrations being α -pinene, linalool and myrtenal. Lowe *et al.* suggested that the genus could prove useful as a commercial source of myrtenal, a substance known to repel aphids, weevils and ticks. The makeup of essential oils produced by the other two genera has not been documented; however, *Astartea* species are distinguishable from *Hypocalymma* species by the odour produced when their leaves are crushed (E. Middleton pers. comm.).

Species groups based primarily on seed and sepal morphology

The following morphological groups may assist in the identification of *Astartea* species, although they do not necessarily reflect relationships.

1. *Astartea aspera* group

Seeds with a thick, reticulate-pitted or colliculate testa. Sepals smooth to very shortly horned. (Two species of the first subgroup have muricate stems.)

a. Seeds uniformly red

A. aspera

A. cicatricosa

A. muricata

b. Seeds partly red

A. decemcostata

A. reticulata

2. *Astartea montana* group

Seeds with a thin, mottled, smooth testa. (Three species of the first subgroup have the hypanthium reticulate-pitted.)

a. Sepals not or scarcely horned

A. astarteoides
A. glomerulosa
A. montana
A. transversa

b. Sepals horned

A. corniculata
A. middletonii
A. schaueri

3. *Astartea scoparia* group

Seeds with a thin, whitish to medium brown, smooth testa.

a. Sepals not horned

A. arbuscula
A. fascicularis
A. laricifolia
A. leptophylla
A. scoparia
A. zephyra

b. Sepals horned

A. affinis
A. eobalta
A. granitica
A. onycis

Generic description

Astartea DC., *Prodr.* 3: 210 (1828). *Baeckea* sect. *Astartea* (DC.) Nied. in A. Engler & K. Prantl, *Nat. Pflanzenfam.* III, 7: 99 (1893). Type: *Astartea fascicularis* (Labill.) DC.

Dwarf to tall *shrubs* or small *trees*, glabrous, many species with a lignotuber. *Leaves* opposite and decussate (very rarely in alternating whorls of three), spreading, often in fascicles on very short lateral branchlets, small, entire, very shortly petiolate, the petiole often poorly defined; blade in most leaves oblong to linear or narrowly obovate from top view and slightly broader and often more obovate from side view, usually with the abaxial surface very deeply convex and the adaxial surface flat or shallowly concave and often with a midline groove, rarely almost terete, dotted with rather inconspicuous to prominent oil glands. *Inflorescence* of solitary, axillary flowers (except in *A. muricata*, which has up to 3 flowers per peduncle and occasionally has two peduncles per axil) in one to many decussate pairs, the pairs widely spaced to rather densely clustered. *Peduncles* straight or somewhat recurved, with two bracteoles at the summit. *Bracteoles* enclosing the bud at first, usually caducous or deciduous but sometimes persistent at anthesis, often slender from side view but broader and more deeply hooded if continuing to enclose the bud as it enlarges, with a herbaceous keel and scarious margins, the margins incurved and the adaxial surface concave, often with a subterminal dorsal point. *Pedicels* usually present, much shorter than to somewhat exceeding the peduncles. *Flowers* predominantly 5-merous, occasionally 4- or 6-merous, protandrous. *Hypanthium* usually obconic to cup-shaped or broadly so, rarely somewhat compressed, often with 5 poorly defined longitudinal ribs opposite the sepals and sometimes also smaller ribs opposite the petals; adnate portion usually green, gland-dotted and

sometimes irregularly rugose-pitted; free portion much shorter than adnate portion, tending to become reddish. *Sepals* usually 5, fairly erect in flower, persistent in fruit, depressed-ovate to semicircular or subtriangular (not including the horn when present), with a herbaceous keel and a more scarious margin; keel incurved, often ridged, sometimes produced into a subterminal, dorsal horn. *Petals* usually 5, widely spreading in flower, deciduous in fruit, broadly obovate to circular, shortly clawed at base, white or pale pink to very deep pink. *Antipetalous processes* variable in number, mostly finger-like, minute. *Androecium* of 3–60 stamens and 0–10 staminodes, all or mostly antisepalous and often in fascicles; fascicles of up to 13 stamens, sometimes with peripheral staminodes, the peripheral filaments longest; antipetalous stamens or staminodes (when present) solitary, often longer than all the antisepalous filaments. *Stamens* shorter than the petals; filament tapering from the base to a slender apex, curved inwards, exceeded by the stigma when the style is mature; anther very broadly to depressed oblong-elliptic in outline; cells parallel and introrse at first but often becoming almost latrorse, longitudinally dehiscent; connective gland small, \pm globular. *Staminodes* (when present) either at margins of the antisepalous fascicles or opposite the petals, usually consisting just of the filament and tapering at apex to a point but sometimes terminating in a club-like reduced anther, often distinctly longer than the stamens. *Ovary* usually 2- or 3-locular but sometimes functionally 1-locular; summit dotted with oil-glands, often green at first, becoming dark red; placentas axile, much reduced when ovules very few, otherwise moderately large, \pm sessile; ovules 1–23 per loculus, usually variable in number between loculi, when numerous arranged in two close rows along the length of the placenta and with ovules radiating at each end of the placenta. *Style* persistent in fruit, terete, the base inserted in a cylindrical cavity; stigma peltate, \pm circular but often slightly 3-lobed from top view. *Fruits* in most species dehiscent by 2 or 3 valves, *c.* half-inferior and \pm circular from top view (but in a few taxa indehiscent, functionally 1-locular, largely inferior and tending to be somewhat compressed or lop-sided), 0.6–3 mm long, somewhat succulent at first, becoming more crustaceous, 1–many-seeded; hypanthium shallowly hemispheric to broadly lobed; summit broad, with top of each loculus raised, convex to acutely angled; inner wall often thin and with a reticulate pattern of cells, sometimes thick and with a bubbly appearance; placentas with usually obvious, small, whitish, raised attachment points for the seeds. *Seeds* 1–many per cell, with the body usually tapering from a broad base, narrowest above the hilum, (0.5–)0.6–1.3 mm long, with outer surface rounded, if numerous then sometimes with the lateral surfaces somewhat flattened; testa with a fine reticulate pattern of numerous rows of minute cells, smooth, shallowly pitted (a pit corresponding to each reticulation) or colliculate, cream to golden brown or red-mottled to uniformly deep red-brown, shiny; hilum small, directly below a fairly inconspicuous to prominent protrusion on inner surface; inner protrusion succulent when young, white to reddish, usually somewhat to very differently coloured from the remainder of the seed. *Chaff pieces* usually irregularly shrunken, rarely seed-like, often brown to dark reddish.

Etymology. Named after the Semitic goddess of love and fertility, Astarte, for whom the myrtles were sacred.

Common names. No common names have been used for members of this genus except for one species that was given an inappropriate common name because it was previously considered to be a *Baeckea* species. New common names are coined here for some of the species.

Key to the species and subspecies of *Astartea*

Important differences between *Astartea* species include habit (e.g. whether lignotuberous), mature seed characters and habitat, all of which are not always apparent from herbarium material. A more flexible means of identifying *Astartea* species, currently available at PERTH, is an interactive key to the entire tribe (Rye *et al.* 2011–).

1. Ovary functionally 1-locular or 2-locular in most or all flowers; ovules 1–10 in one loculus but often absent or few in the other loculus. Fruits indehiscent or dehiscent, when 1-locular the style base off-centre and only shortly inset
2. Flowers 1.5–2.5 mm diam. Stamens 3–5, not in fascicles. Ovary functionally 1-locular, with 1 or rarely 2 ovules
3. Leaves mostly not in fascicles, always opposite, 2.5–5 mm long. Fruits with the hypanthium somewhat compressed bilaterally; seed obliquely positioned, ± broadly ovoid, off-white to golden brown (Lake Jasper–Albany)..... **A. arbuscula**
- 3: Leaves mostly in dense fascicles, sometimes in whorls of three, 2–2.5 mm long. Fruits not compressed; seed transverse, ± reniform, with reddish markings (Millbrook area)..... **A. transversa**
- 2: Flowers 3.5–6.5 mm diam. Stamens usually more than 5, often in antisepalous fascicles. Ovary functionally 1- or 2-locular, usually with several ovules per loculus
4. Ovary functionally 2-locular, with 2–10 ovules per loculus. Fruits usually dehiscent
5. Leaves mostly in fascicles, 2.5–4.5 mm long. Outer sepals with a prominent dorsal horn 0.4–1 mm long (Walpole–east of Albany)..... **A. corniculata**
- 5: Leaves mostly not in fascicles, 4–10 mm long. Outer sepals smooth to strongly ridged (Brookton Highway–Donnelly River–Scott River)..... **A. zephyra**
- 4: Ovary functionally 1-locular, with 1–6 ovules. Fruits (where known) indehiscent
6. Petals deep pink. Stamen filaments 0.5–0.6 mm long. Style 0.6–0.8 mm long (Denmark area)..... **A. arbuscula × corniculata**
- 6: Petals white or pale pink. Stamen filaments 0.6–1.1 mm long. Style 1.2–1.6 mm long (Brookton Highway–Donnelly River–Scott River)..... **A. zephyra**
- 1: Ovary 3-locular in most flowers; ovules 3–23 per loculus. Fruits dehiscent by valves; style base immersed to the level of the placentas in a long central depression
7. Mature seeds with a thick, shallowly reticulate-pitted or colliculate testa, usually uniformly dark red-brown and strongly contrasting with the white inner protrusion (but with chaff pieces often lacking the colour contrast) or with a reticulate red pattern rather than a uniform one. (Two species that key here can be distinguished by having young stems with crown-shaped outgrowths)
8. Plants either with crown-shaped outgrowths on the young stems or with smooth sepals. Seeds uniformly dark red or red-brown at maturity
9. Young stems fairly smooth. Stamens 40–53, in fascicles of 5–11 opposite each sepal and usually also with a single stamen opposite all or some of the petals. Outer sepals not ridged (Upper Jerdacuttup River–Hopetoun–Darkanuttup)..... **A. cicatricosa**
- 9: Young stems with crown-shaped outgrowths. Stamens 15–35, with 1–11 opposite each sepal and rarely any opposite petals. Outer sepals usually ridged

10. Petioles 0–0.5 mm long. Peduncles sometimes paired in the axils, much longer than the pedicels at all stages, up to 3-flowered. Ovules 10–16 per loculus. Occurring well inland (Hotham and Avon Rivers–Dumbleyung area) **A. muricata**
- 10: Petioles 0.5–0.8 mm long. Peduncles always solitary, much shorter than to much longer than the pedicels in late flower and in fruit, always 1-flowered. Ovules 6–12(–14) per loculus. Occurring on or near the south coast
11. Young stems with numerous, rather crowded, crown-shaped outgrowths. Peduncles 1–2.5 mm long, often shorter or not much longer than the mature pedicels (South Stirling area–Fitzgerald River NP)..... **A. aspera** subsp. **aspera**
- 11: Young stems with crown-shaped outgrowths few to numerous, sometimes barely developed. Peduncles 2.5–5 mm long, longer (usually much longer) than the mature pedicels (Fitzgerald River–Lort River)..... **A. aspera** subsp. **riparia**
- 8: Plants lacking crown-shaped outgrowths, the sepals strongly ridged or horned. Seeds partially dark red at maturity
12. Petioles 1–1.5 mm long. Hypanthium rather strongly 10-ribbed. Occurring in gullies on quartzite (Mt Barren Ranges) **A. decemcostata**
- 12: Petioles 0.4–0.8 mm long. Hypanthium not ribbed or somewhat 5-ribbed. Occurring in swamps or along creek lines (Fitzgerald River NP–Esperance) **A. reticulata**
- 7: Mature seeds with a thin, uniformly cream to medium brown or red-mottled testa with a smooth, reticulate pattern on the surface (i.e. cells level rather than being pitted or convex)
13. Young stems prominently winged; wings distinctly expanded at the apex. Pedicels usually much longer than the peduncles. Occurring in very damp habitats, often in gullies (Preston River–Augusta–Cape Riche)..... **A. laricifolia**
- 13: Young stems not winged to moderately winged; wings (when present) fairly uniformly expanded. Pedicels usually shorter than, or similar in length to, the peduncles. Occurring in varied damp habitats including granite outcrops, swamps and river banks
14. Hypanthium (of old buds and young flowers) deeply reticulate-pitted. Petals usually pale to medium pink
15. Shrubs with a lignotuber. Staminodes often present on margins of fascicles or opposite petals. Occurring mainly on and between peaks in a mountain range (Stirling Range area) **A. montana**
- 15: Single-stemmed shrubs. Staminodes absent. Occurring on the margins of swamps
16. Peduncles 2–4 mm long. Stamens 5–11, with 0–3 per sepal, mostly not in fascicles. Occurring east of Hopetoun (Esperance–Cape Arid NP)..... **A. astarteoides**
- 16: Peduncles (2–)4–10 mm long. Stamens usually 15–21, with 1–6 per sepal, all or mostly in fascicles. Occurring west of Hopetoun (Donnelly River–east of Albany) **A. glomerulosa**

- 14:** Hypanthium (of old buds and young flowers) smooth or somewhat rugose or with oil glands prominent, but not very pitted. Petals usually white or pale pink
- 17.** Plants restricted to granite outcrops or coastal granite. Flowers 8–15 mm diam. Stamens 5–13 per fascicle, flanked by staminodes in one species, the other two species with long-horned sepals
- 18.** Young stems with prominently thickened, pale grey stripes below each petiole and alternating with reddish brown stripes. Sepals prominently ridged, not horned. Stamen fascicles flanked by 1 or 2 long staminodes. Ovules 14–23 per loculus. Occurring on coastal granite (Recherche Archipelago and adjacent coast).....**A. fascicularis**
- 18:** Young stems with thinner, more irregular, pale grey stripes. Sepals long-horned. Stamen fascicles mostly without any staminodes. Ovules 10–15 per loculus. Occurring in soil pockets on granite outcrops
- 19.** Single-stemmed shrubs, killed by fires. Mature seeds produced copiously, uniformly coloured (Granite outcrops north of Walpole)**A. granitica**
- 19:** Lignotuberous shrubs, resprouting after fires. Mature seeds apparently rarely produced, partially red (Granite outcrops north of Broke Inlet)..... **A. middletonii**
- 17:** Plants associated with watercourses and runoff areas from rocks and swamps. Flowers 4–11 mm diam. Stamens 0–11 opposite each stamen, if sepals long-horned then some fascicles absent or with less than 5 stamens
- 20.** Seeds developing reddish markings. (Sepals prominently horned in both species)
- 21.** Shrub 0.5–2 m high. Peduncles 4–7 mm long. Flowers 8–11 mm diam. (Broke Inlet–Denmark area)**A. schaueri**
- 21:** Shrub usually 0.3–0.5 m high. Peduncles 1.5–3.5 mm long. Flowers 4–6.5 mm diam. (Walpole–east of Albany)..... **A. corniculata**
- 20:** Seeds uniformly off-white to golden brown
- 22.** Tall shrub or small tree to 5 m high, single-stemmed or with a row of stems through layering (usually with particularly slender leaves). Restricted to river banks subject to destructive flooding (Helena River–Hay River) **A. leptophylla**
- 22:** Small to tall shrubs 0.3–3 m high, lignotuberous or single-stemmed, not layering. Associated with swamps or other wetlands, not on major river banks
- 23.** Shrubs single-stemmed or multi-branched at the base, not lignotuberous
- 24.** Outer sepals strongly ridged or shortly horned; horn up to 0.4 mm long. Stamens 21–31, all in antisepalous fascicles of 3–8. Ovules 7–14 per loculus (Cape le Grand NP–Cape Arid NP).....**A. eobalta**
- 24:** Outer sepals prominently horned; horn 0.9–1.4 mm long. Stamens 6–18, some (rarely all) in antisepalous fascicles of 2–5, usually with solitary stamens or no stamens opposite at least one of the sepals. Ovules 3–9 per loculus (Scott River area–D’Entrecasteaux NP)..... **A. onycis**

23: Lignotuberous shrubs, resprouting by multiple close basal shoots

25. Young stems usually with a delicate-looking, grey epidermis dotted with small dark glands, with leaves mostly in fascicles. Outer sepals smooth to strongly ridged, not horned (Moore River–Albany).....**A. scoparia**

25: Young stems not as above, the leaves mostly not in fascicles. Outer sepals with a horn 0.3–1 mm long (Gingin–Augusta area).....**A. affinis**

Species descriptions

Astartea affinis (Endl.) Rye, *Nuytsia* 16: 150 (2006). *Baectea affinis* Endl. in S.L. Endlicher, E. Fenzl & G. Bentham, *Enum. Pl.* 51 (1837). *Astartea endlicheriana* Schauer *nom. illeg.*, *Linnaea* 17: 242 (1843). *Type:* ‘King George Sound’ [actually probably collected near Perth, Western Australia, November–December 1833], C.A. von Hügel *s.n.* (*lecto:* W *n.v.*, photograph seen, left specimen on sheet, *fide* B.L. Rye, *Nuytsia* 16: 150 (2006); possible *isolecto:* central and right specimens on the sheet bearing the lectotype (W *n.v.*, photograph seen).

Astartea sp. Brixton Rd (G.J. Keighery 5389), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002).

Astartea sp. Waroona (R.J. Cranfield 11429), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Illustration. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002) [as *Astartea* sp. Brixton Rd (G.J. Keighery 5389)].

Erect slender *shrub*, 1–2 m tall at maturity, multi-stemmed from a lignotuber, with slender stems and relatively long branchlets, the flowering stems erect to spreading or sometimes weeping; young (actively growing) stems somewhat 4-ridged, not or scarcely winged, reddish; older stems pale grey. *Leaves* widely spaced on the rapidly growing shoots, sometimes in fascicles lower down but mostly not fasciculate, antrorse to widely spreading, fairly straight. *Petioles* 0.5–1.1 mm long, poorly defined and often appearing to be absent. *Leafblades* very narrowly obovate to linear from side view, 5–15(–20) mm long, 0.3–0.6(–1.1) mm wide, 0.6–1.1 mm thick, sometimes mucronate. *Inflorescence* of 2–12(–20) pairs of flowers spread along each branchlet. *Peduncles* 1–4 mm long. *Bracteoles* 1.5–3.5 mm long, 0.4–0.7(–1.1) mm wide, acuminate, hooded, with a subterminal point 0.1–0.6 mm long. *Pedicels* 0.6–2 mm long. *Buds* 5-horned. *Flowers* 5.5–8.5(–11) mm diam. *Hypanthium* 1.5–3(–3.5) mm long, 2–2.5(–3) mm wide; adnate portion dotted with numerous small oil glands, not obviously pitted; free portion 0.4–0.7 mm long. *Outer sepals* 0.4–1 mm long excluding and 0.5–1.2 mm long including the horn, 1.1–1.7 mm wide, slightly to prominently horned; scarious margin narrow; horn 0.3–1 mm long. *Petals* 1.8–3(–3.5) mm long, white or pale pink; margin entire or irregularly denticulate. *Androecium* of 14–28(–42) stamens, in fascicles of 2–7(–10) opposite all or most sepals, sometimes with a solitary stamen opposite one sepal; filaments connate for up to 0.6 mm, the longest 1–1.5 mm long; anthers 0.25–0.3 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 5–12 per loculus. *Style* 1.4–2.3 mm long, the basal *c.* 0.4 mm immersed; stigma up to 0.35 mm wide. *Fruits* 3-valvate, usually 2–2.3 mm long, 2–3 mm diam.; hypanthium somewhat 3-lobed, fairly smooth; undeveloped ovules/seeds dark red-brown. *Seeds* commonly 1–3 per loculus, 0.7–1.3 mm long, 0.4–0.6 mm thick; testa thin, pale golden brown, reticulate-patterned, smooth. (Figure 1B)

Diagnostic features. Lignotuberous *shrub* associated with winter-wet depressions. *Flowers* 5.5–11 mm diam. *Sepals* horned. *Petals* 1.8–3.5 mm long, white or pale pink. *Stamens* 14–28(–42). *Staminodes* usually absent. *Ovary* 3-locular; ovules 5–12 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERN AUSTRALIA: ‘ex horto bot. Petropolitano’, anon. s.n. (K); Yallingup, Dec. 1930, *W.E. Blackall* s.n. (PERTH); Twin Swamp Wildlife Sanctuary, Reserve A27621 in the Ellensbrook to Bullsbrook area, 28 Dec. 1971, *N.T. Burbidge* 7949 (PERTH); 2.8 km [actually more] N of Waroona, rail/road reserve, 29 Oct. 1997, *R.J. Cranfield* 11429 (PERTH); Bowelling–Duranillin road, between Trigwell Bridge Rd and Wunnenberg Rd, SW of Bowelling, 27 Nov. 1994, *V. Crowley* DKN 426 (PERTH); Picton Junction, Nov. 1900, *F.L.E. Diels & E.G. Pritzel* s.n. (PERTH); Brixton Rd, Beckenham, Perth, 19 Nov. 1982, *G.J. Keighery* 5389 (CANB, PERTH); 1 km N of Serpentine, 13 Nov. 1983, *G.J. Keighery* 6563 (PERTH); Chester Forest Block, between Augusta and Nannup, 31 Dec. 1990, *G.J. Keighery* 13463 (PERTH); lower Canning River, 2 Jan. 1899, *R. Helms* s.n. (PERTH); Pinjarrah [Pinjarra], 3 Dec. 1877, *F. Mueller* s.n. (MEL 75995); Preston River, 8 Dec. 1877, *F. Mueller* s.n. (MEL 76007); Wellington district, Dec. 1900, *E. Pritzel* 87 (AD); 10 m S of creek, 2 km N of Gracetown, 1.5 km NW of Margaret River, 3 Nov. 2006, *D. Rooks* 222 (PERTH); Mooliabeenee, E of Gingin, 15 Dec. 1953, *R.D. Royce* 4745 (PERTH); W side of South Western Hwy, 0.3 km N of Wealand Rd, N of Waroona, 1 Dec. 2002, *B.L. Rye* 221202 (CANB, PERTH); Waterloo, 20 Dec. 1984, *Paul G. Wilson* 12148 (CANB, PERTH).

Distribution and habitat. Occurs mainly close to the west coast from near Gingin south to the Yallingup–Augusta area, also extending inland to near Bowelling (Figure 7A). *Astartea affinis* is found mainly in winter-wet depressions that have a clay layer below the more sandy topsoil, commonly with *Melaleuca* species over sedges and other wetland plants.

Phenology. Flowering is mainly in autumn and early summer, from late October to early January, but there are spasmodic records through to mid-April.

Common name. West-coast *Astartea*.

Conservation status. This species has numerous populations spread over a relatively large range and is not considered to be at risk.

Etymology. From the Latin *affinis* (related to), as Endlicher (in Endlicher *et al.* 1837) believed the species was closely related to the eastern Australian species *Baeckea linifolia* Rudge. However, any similarity between the two taxa is superficial and they show many significant differences.

Affinities. Shows a number of similarities to *A. onycis* Rye & Trudgen, differing as discussed under that species. *Astartea affinis* tends to have its leaves more uniformly spaced (i.e. with less tendency for them to be in fascicles) than in the two main species found within its range, *A. scoparia* and *A. leptophylla*, also differing from both of those species by the presence of a short or long horn on its sepals.

Co-occurring taxa. *Astartea affinis* overlaps considerably in its distribution with *A. leptophylla*, *A. scoparia* and *A. zephyra*, and to a lesser extent with a number of other species, the most common species within its range being *A. scoparia*. Habitat differences tend to keep *A. affinis* and *A. scoparia* separated, as the former is more commonly found in soils with a layer of clay whereas the latter is often found in soils with a greater sand content. However, *A. scoparia* seems more versatile in its

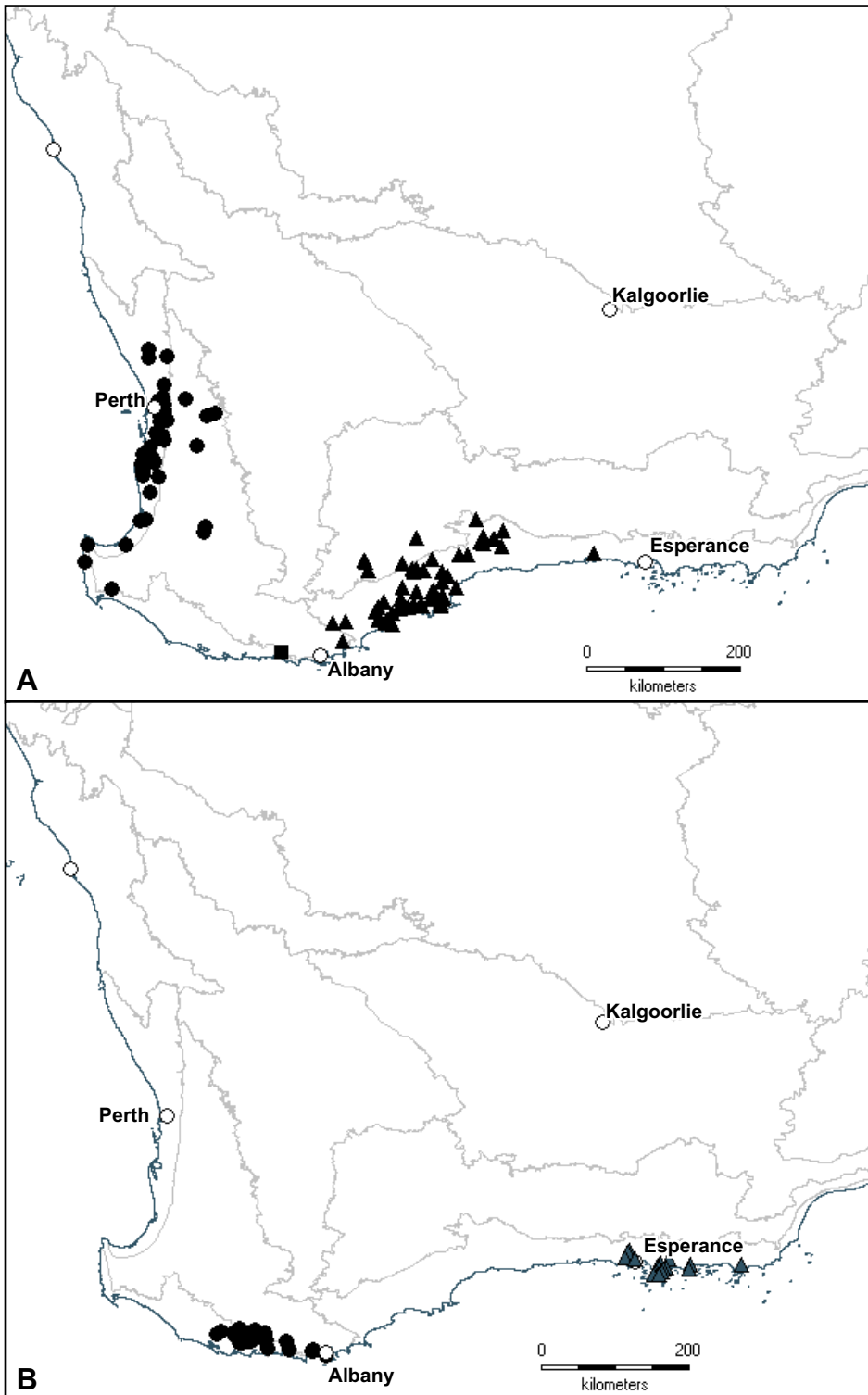


Figure 7. Distributions of *Astartea* species and a presumed hybrid. A – *A. affinis* (●), *A. arbuscula* × *A. corniculata* (■), *A. aspera* (▲); B – *A. arbuscula* (●), *A. astarteoides* (▲).

habitats than most other species of *Astartea* and, in the rare instances where it sometimes comes into contact with *A. affinis*, differences in flowering time may also be important in maintaining the integrity of the species. *Astartea affinis* (D. Bright & C. Mykytiuk GAA 05 B) was recorded growing with *A. scoparia* (D. Bright & C. Mykytiuk GAA 05 A) at a site in the suburb of Wellard, Perth in early February 2005. The former species was collected in bud and flower while the latter had finished flowering and had fruits attached.

Notes. A possible earlier name for this species is *Leptospermum dubium* Spreng. (Sprengel 1825), as discussed under *Doubtful names* below.

Extreme variation of flower size has been observed in a recent field survey of a population near Waroona. A large-leaved and large-flowered variant with numerous stamens and ovules, had previously been distinguished as *A. sp.* Waroona (R.J. Cranfield 11429). However, the large-flowered variant was found to intergrade completely with smaller-flowered specimens in this population. Flower colour also varied considerably there, from almost white to medium pink. The largest flowers recorded elsewhere for *A. affinis* are in two specimens from near Pinjarra (G.J. Keighery 13135 & 14053), with petals 2.5–3 mm long and flowers up to 8.5 mm diam.

Astartea affinis also appears to be extremely variable in the degree of horning on the sepals, sometimes within a single population; for example some of the material collected from a population near Jandakot (G.J. Keighery 12756) has long horns and uniformly long leaves (a single piece on the left side of the specimen) while the remainder (two pieces) has short horns and shorter leaves on average.

Astartea arbuscula (R.Br. ex Benth.) Rye, *Nuytsia* 16: 152 (2006). *Baeckea arbuscula* R.Br. ex Benth., *Fl. Austral.* 3: 79 (1867). *Type:* King George Sound, Western Australia [precise locality withheld for conservation reasons], December 1801, R. Brown s.n. (*holo:* BM 000758991; *iso:* K, NSW 497662).

Illustrations. S.J. Patrick & S.D. Hopper, *A guide to the gazetted rare flora of Western Australia: Supplement 1*, report No. 54: 15 (1982); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 689 (2002) [as *Baeckea arbuscula* in both publications].

Dwarf or small *shrub* 0.1–0.3(–0.4) m tall, widely spreading at maturity (often with some stems widely spreading or trailing) and usually broader than high, fairly dense, single-stemmed at base, without a lignotuber; young (actively growing) stems not or scarcely winged; older stems with strips of pale grey epidermis or fully dark red-brown except for small patches of grey below each axil. *Leaves* spreading, mostly distant, almost straight or slightly incurved. *Petioles* 0.3–0.6 mm long, poorly defined. *Leaf blades* narrowly or very narrowly obovate from side view, 2.5–5 mm long, 0.25–0.4 mm wide, 0.4–0.6 mm thick, acute or almost acute, mucronate, smooth or somewhat rugose. *Inflorescence* usually of many pairs of flowers per main branchlet, with 1 or several pairs clustered on the much shorter lateral branchlets. *Peduncles* slightly to strongly recurved, 0.5–1.5 mm long. *Bracteoles* 0.3–0.45 mm long, up to 0.2 mm wide, rather scarious and reddish throughout, entire; apex usually somewhat hooded, with midrib terminating in a mucro or short point. *Pedicels* absent or up to 0.3 mm long. *Buds* with a 5-lobed apex. *Flowers* 1.5–2 mm diam. *Hypanthium* somewhat bilaterally compressed and lop-sided, longer on the abaxial edge than the adaxial one, 0.5–0.7 mm long, c. 1 mm wide; adnate portion usually irregularly broadly 5-ribbed and somewhat rugose, with large oil glands; free portion 0.1–0.2 mm long. *Outer sepals* 0.15–0.3 mm long, 0.25–0.5 mm wide, dorsally ridged; scarious margin narrow, entire to minutely lacinate. *Petals* 0.4–0.6 mm long, pale to deep pink; margin minutely denticulate to entire. *Androecium* of (4)5 stamens, usually one opposite each of the sepals but sometimes one

sepal lacking a stamen; filaments free, 0.1–0.25 mm long; anthers *c.* 0.15 mm long; staminodes absent. *Ovary* functionally 1-locular, with a very reduced adaxial loculus, the fertile loculus large and abaxial; placenta very reduced and close to top of ovary; ovule 1. *Style* displaced towards the adaxial side of ovary summit, 0.4–0.6 mm long, the base not or scarcely immersed; stigma less than 0.1 mm wide. *Fruits* indehiscent, largely inferior, somewhat compressed, lop-sided with end furthest from stem forming a slight ‘beak’, 0.5–0.7 mm long, 0.8–1 mm wide, 1-seeded. *Seed* oblique, irregularly ovoid, with the narrower end occupying the ‘beak’ of the fruit, 0.6–0.7 mm long, 0.45–0.5 mm thick; testa very thin, ± membranous, off-white to golden brown, smooth.

Diagnostic features. Low, single-stemmed *shrub* occurring in winter-wet depressions. *Flowers* 1.5–2 mm diam. *Sepals* dorsally ridged. *Petals* 0.4–0.6 mm long, pale to deep pink. *Stamens* (4)5. *Staminodes* absent. *Ovary* functionally 1-locular, 1-ovulate. *Seeds* with a very thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERNAUSTRALIA [localities withheld for conservation reasons: Dec. 1902, *C.R.P. Andrews s.n.* (NSW); 5 Jan. 1903, *C.R.P. Andrews* 1276 (PERTH); 9 Feb. 1995, *A.R. Annels* 5299 & *R.W. Hearn* (PERTH); 13 Feb. 1995, *A.R. Annels* 5309 (PERTH); Feb. 1899, *B.T. Goadby s.n.* (K); 15 Oct. 1996, *M.S. Graham* 637 B & *M.D. Carter* (PERTH); 28 Mar. 2000, *B.G. Hammersley* 2432 (PERTH); 5 Aug. 1994, *R.W. Hearn* 4385 (PERTH); 10 Sep. 1986, *G.J. Keighery* 8361 (PERTH); 4 Dec. 2002, *B.L. Rye* 221245 & *R.W. Hearn* (PERTH).

Distribution and habitat. Extends along the south coast from the Pingerup Plains area east to Kalgan River (Figure 7B). Found on pale grey sand to peaty black sandy clay on winter-wet flats in heath, associated with other wetland shrubs such as *Pericalymma* species, often in paperbark (*Melaleuca*) woodlands, with open low sedgeland or tall sedges.

Phenology. Flowers recorded mainly from late December to mid-March.

Common name. Minute Astartea.

Conservation status. Priority Four under the Department of Environment and Conservation’s (DEC) Conservation Codes for Western Australian Flora (Smith 2012). This species was previously poorly collected, probably mainly because of its very small stature and inconspicuous leaves and flowers, the latter so minute that it is hard to tell when the plant is flowering. It was included, as *Baেকেa arbuscula*, among the Declared Rare Flora treated in Patrick and Hopper (1982), who stated that it had not been collected since 1936. This prompted a search for the species and two populations were located in 1986, together with the first collections of a new species, *A. transversa*, which had only slightly larger flowers. Both taxa were considered to be *B. arbuscula*, as in the report on endangered flora for the Albany district (Robinson & Coates 1995). *Astartea arbuscula* is now known from many collections over a range of *c.* 135 km, including several national parks.

Etymology. From the Latin *arbuscula* (shrub), referring to the habit of this erect, single-stemmed subshrub.

Affinities. See the notes under two other taxa that can have a functionally unilocular ovary, *A. transversa* and *A. zephyra*. *Astartea arbuscula* appears to have closer affinities to the latter species than to *A. transversa*. However, it is similar to *A. transversa* in having very short stamen filaments and a

maximum of one stamen opposite each of the sepals, whereas *A. zephyra* has more numerous stamens and longer filaments.

Co-occurring taxa. This species is found with various other *Astartea* species at most or all of its localities. However, it tends to be somewhat isolated from most other taxa as it occurs in the more water-logged parts of winter-wet depressions where there is normally only very low-growing vegetation. It appears to be able to hybridise with *A. corniculata*, which also extends into the more water-logged parts.

Notes. While it was included in the genus *Baeckea*, this species had the common name Albany Baeckea, since its earliest collections came from Albany. It would be more appropriate to have a common name referring to its minute habit and flowers; hence the one chosen here is Minute *Astartea*.

Astartea arbuscula has exceptionally small flowers, the smallest in the tribe and in the entire family. It is most unusual, perhaps unique, in having a bilaterally compressed, lop-sided hypanthium, and it shows the greatest uniformity of stamen number in the genus, with most or all flowers having five stamens.

Astartea aspera Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 114 (1844). *Type:* ‘In rupestribus collium Konkoberup promontorii Cape Riche’ [rocky site, Mt Melville, near Cape Riche, Western Australia], 20 November 1840, *L. Preiss* (Herb. Preiss No.) 361 (*holo:* LD).

Spreading *shrub*, 0.15–1 m tall, single-stemmed at base but tending to be multi-branched from or just above the ground level, often with trailing stems as well as more erect ones, muricate on stems and often also leaves and peduncles; young (actively growing) stems usually prominently muricate, with glands modified into crown-like outgrowths, these only rarely rather obscure; older stems with pale grey epidermis usually retaining obvious crown-like protrusions, the epidermis irregularly splitting and shed lower down to reveal a brown, fibrous layer. *Leaves* moderately spreading, often crowded or in fascicles. *Petioles* 0.5–0.8 mm long. *Leaf blades* linear to narrowly obovate in outline, 2.5–11 mm long, 0.5–0.8 mm wide, 0.7–1.1 mm thick, obtuse, often somewhat muricate. *Inflorescence* of 1–10 pairs of flowers per branchlet, flowers tending to be clustered towards the end of the branchlet. *Peduncles* 1-flowered, 1–5 mm long, often muricate. *Bracteoles* deciduous or persistent, 0.7–1.7 mm long, 0.3–0.4 mm wide, hooded, largely scarious, the margin entire; point absent. *Pedicels* 0.5–2 mm long. *Flowers* 6.5–12 mm diam. *Hypanthium* 1.7–2.2 mm long, 2.5–3.5 mm diam.; adnate portion not or scarcely pitted; free portion 0.4–0.6 mm long. *Outer sepals* 0.5–1.3 mm long, 1.2–1.7 mm wide, smooth to prominently ridged dorsally; scarious margin often deep pink or reddish, entire. *Petals* 2–4 mm long, pale pink or white; margin entire. *Androecium* of 15–35 stamens, usually all in distinct fascicles of 2–10 opposite the sepals but sometimes reduced to a solitary stamen opposite one or two sepals, or sometimes with connections between the stamen fascicles and then sometimes with a solitary stamen opposite 1 or 2 of the petals; filaments connate for up to 0.5 mm, the longest 0.7–1.7 mm long; anthers 0.25–0.4 mm long; staminodes few or absent, on the margin of a stamen fascicle, up to 2 mm long. *Ovary* 3(4)-locular; ovules (6)7–12(–14) per loculus. *Style* 1.3–2.4 mm long, the basal 0.4–1 mm immersed; stigma 0.25–0.5 mm wide. *Fruits* 3(4)-locular, 1.8–2 mm long, 3 mm diam.; abortive ovules/seeds brown to dark red-brown. *Seeds* usually 1–5 per loculus, 0.7–1.3 mm long, 0.5–0.7 mm thick; testa moderately thick, uniformly medium brown to very dark red-brown, reticulate-pitted or colliculate (usually shallowly pitted on viable seeds), contrasting with a white or off-white inner protrusion.

Diagnostic features. Single-stemmed or basally branched *shrub* associated with various winter-wet habitats, often with muricate stems. *Flowers* 6.5–12 mm diam. *Sepals* smooth to prominently ridged.

Petals 2–4 mm long, white or pale pink. *Stamens* 15–35. *Staminodes* usually absent. *Ovary* 3-locular; ovules 6–14 per loculus. *Seeds* with a thick testa, dark red-brown, reticulate-pitted.

Distribution. Extends from the South Stirling area north-east to Phillips River (Figure 7A).

Etymology. From the Latin *asper* (rough), referring to the rough texture of the stem and leaves caused by the stellate protrusions.

Common name. Rough-stemmed Astartea.

Affinities. *Astartea aspera* is closely related to *A. muricata* and *A. cicatricosa*. The former two species can usually be readily distinguished from *A. cicatricosa*, and also from all other members of the genus, by the crown-like outgrowths on the young stems and sometimes also on the peduncles and young leaves. Turczaninow (1852) recognised a third strongly muricate species, *A. clavulata* (see under subsp. *aspera*), choosing this epithet apparently to reflect the leaf shape. He considered *A. clavulata* to be distinguished from *A. aspera* in having more numerous stamens per fascicle, and from *A. muricata* in having the sepals with a particularly prominent dorsal ridge and the pedicels tending to be longer than the peduncles, which were shorter than the leaves, whereas *A. muricata* had a relatively smooth dorsal surface to the sepals and long peduncles that were about as long as the leaves and longer than the pedicels. The type of *A. clavulata* evidently had a semi-prostrate habit, with the stem outgrowths less obvious than on the type specimens of both *A. aspera* and *A. muricata*. While *A. muricata* is maintained here as a distinct taxon, as discussed under its description below, *A. aspera* is now known to be very variable in stamen number and *A. clavulata* is treated as a synonym.

Hypocalymma asperum Schauer, which overlaps considerably in range with *A. aspera*, has very similar muricate stems; this convergence led Schauer (1844) to choose the same epithet for the two species.

Co-occurring taxa. At one locality near Cape Riche *A. aspera* has been recorded with *A. laricifolia*, but how commonly it occurs with other species is not known.

Notes. A few specimens of *A. aspera* are described on the labels as being lignotuberous, but this needs confirmation as no herbarium specimens are of whole plants. Plants examined in the field in the current study were single-stemmed but with the older plants multi-branched at the base, a characteristic that can be readily mistaken for a lignotuberous habit. The species is very variable and two subspecies are recognised.

Astartea aspera* subsp. *aspera

Astartea clavulata Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersburg* 10: 333 (1852). *Type:* Swan River Colony [Stirling Range to Cape Riche and Mt Barren Range, Western Australia], 1848–1849, J. Drummond coll. 5, n. 128 (*holo:* KW n.v., photograph PERTH 07523610; *iso:* K (three sheets), NSW 531335, PERTH 01605097).

Illustration. B.L. Rye & M.E. Trudgen, *Nuytsia* 18: 244, Figure 3A (2008).

Spreading *shrub*, 0.15–1 m tall, often with trailing stems as well as more erect ones; young (actively growing) stems prominently muricate. *Petioles* 0.5–0.7 mm long. *Leaf blades* linear to narrowly obovate in outline, 2.5–5(–8) mm long, 0.5–0.8 mm wide, 0.7–0.9 mm thick, often somewhat muricate.

Peduncles 1–2.5 mm long, often muricate, often exceeded by or not much longer than the pedicels. *Bracteoles* 0.7–1.3 mm long. *Flowers* 6.5–11 mm diam. *Outer sepals* 0.5–1.3 mm long, 1.2–1.7 mm wide, smooth to prominently ridged dorsally. *Stamens* 15–33. *Ovules* (6)7–12 per loculus. *Style* usually 1.3–2 mm long. *Seeds* 0.8–1.3 mm long, shallowly pitted on viable seeds and contrasting with a white or off-white inner protrusion. (Figure 4A)

Diagnostic features. Spreading *shrub* with prominently muricate stems. *Leaves* 2.5–5(–8) mm long. *Peduncles* 1–2.5 mm long. *Stamens* 15–33. *Ovules* 6–12 per loculus.

Selected specimens examined. WESTERNAUSTRALIA: S of Ongerup on the border to Jerramungup, Green Range Rd, 24 Oct. 1969, *A.M. Ashby* 3080 (AD); Bremer Bay Rd off Hassel Hwy, 29 Oct. 1983, *E.J. Croxford* 3175 (PERTH); Mt Melville near Cape Riche, 26 Oct. 1965, *A.S. George* 6903 (PERTH); South Stirling Nature Reserve, 24 Oct. 1991, *G.J. Keighery* 12560 (PERTH); Wellstead, 40 m along a small vehicular track opposite the Wellstead shops, 23 Oct. 1997, *N. Lam & Peter G. Wilson* (UNSW 23732); 15 mi [24 km] S Mt Toolbrunup, 8 Nov. 1964, *K.R. Newbey* 1701 (PERTH); road from Bremer Bay to Gairdner River, 12 Sep. 1971, *S. Paust* 641 (PERTH); Mettler Lake Rd, at junction of Cape Riche Homestead Rd, 7 Jan. 2010, *B.L. Rye* 290139 (PERTH); ‘King George Sound’, 1888, *Webb s.n.* (MEL).

Distribution and habitat. Extends from the South Stirling area north-east to Fitzgerald River National Park. Grows in a variety of soil types, often in rocky soil or over a substrate of rocks such as laterite, limestone or granite, in winter-wet depressions or sometimes associated with watercourses, with low heath or shrublands or open mallee woodlands.

Phenology. Flowering occurs mainly from August to December, also recorded in January, March and May.

Conservation status. A relatively common taxon that is adequately conserved. Its range includes the Fitzgerald River National Park.

Notes. This is the only *Astartea* to have been collected at its type locality of Mt Melville, and it is common in the Cape Riche area. Stamen number is very variable in this taxon, especially near Cape Riche. A few specimens along the southern border of the distribution have unusually low stamen numbers, the most extreme being *C.A. Gardner* 6542 in which there are only 1–3 stamens opposite each sepal. The highest stamen numbers known are on northern specimens such as *S. Paust* 641, with up to 8 or possibly more per fascicle.

Specimens (e.g. *R. Davis* 10176) with particularly short peduncles similar to those on the type of *A. clavulata* have been recorded in the southern part of the range from the South Stirling area east to near Point Ann, while specimens with longer peduncles have been recorded throughout the range. Coastal specimens in areas of low coastal vegetation tend to have a lower, more ground-hugging habit than those from more sheltered locations. The sepals are never horned but in many specimens the dorsal surface is very prominently ridged.

Both *R. Davis* 10176 and *R.E. Moir* 25 occasionally have flowers with a stamen directly opposite one of the petals, with the stamens united across that point to the adjacent sepals, although the antisepalous fascicles are still obvious.

Astartea aspera* subsp. *riparia* Rye, *subsp. nov.

Typus: at Phillips River crossing on Aerodrome Road, 3.0 km west of Thomas Road, Western Australia, 9 December 2003, *B.L. Rye* 231212 (*holo*: PERTH 06585922; *iso*: CANB, K, MEL).

Shrub, commonly low and spreading and 0.2–0.4 m high but up to 1 m high, recorded up to 2 m wide, single-stemmed at base but often branching close to base, sometimes layering; young (actively growing) stems usually with scattered, crown-like outgrowths. *Leaf blades* linear in outline, 6–11 mm long, 0.6–0.8 mm wide, 0.7–1.1 mm thick. *Petioles* 0.6–0.8 mm long. *Peduncles* 2.5–5 mm long, longer (usually much longer) than the pedicels. *Bracteoles* 0.8–1.7 mm long. *Flowers* 8–12 mm diam. *Outer sepals* 1–1.2 mm long, slightly to prominently ridged. *Petals* 2–4 mm long, pale pink or white. *Stamens* 26–35. *Ovules* 9–14 per loculus. *Style* 1.8–2.4 mm long. *Seeds* 0.7–1.2 mm long, shallowly reticulate-pitted or colliculate.

Diagnostic features. Distinguished from subsp. *aspera* by its longer peduncles (2.5–5 mm), also tending to have less muricate stems, longer leaves (6–11 mm) and more numerous stamens (26–35) and ovules (9–14).

Selected specimens examined. WESTERN AUSTRALIA: Phillips River, 16 km W of Ravensthorpe, 23 Nov. 1997, *B. Archer* 899 (PERTH); Fitzgerald River, E of Roes Rock, 18 Dec. 1970, *A.S. George* 10544 (PERTH); crossing of Phillips River, c. 15 km SW of Ravensthorpe on main road to Ongerup, 18 Sep. 1976, *L. Haegi* 1039 (NSW, PERTH); Phillips River crossing on Aerodrome Rd, 3 km W of Thomas Rd, 9 Dec. 2003, *B.L. Rye* 231211 (AD, DNA, PERTH); Lort River crossing, South Coast Hwy, c. 300 m S of bridge, 22 Oct. 1997, *Peter G. Wilson* 1424 (NSW, PERTH).

Distribution and habitat. Extends from Fitzgerald River east to Lort River, often on the rocky banks of watercourses. The type collection was made from soil pockets and crevices in granite along a river bank, in vegetation dominated by *Melaleuca*.

Phenology. Flowers mainly September to December.

Conservation status. Not currently considered to be at risk. Its known range is about 170 km long and includes some large populations.

Etymology. From the Latin *ripa* (the bank of a stream), as most or all occurrences are on the banks of watercourses.

Notes. This subspecies occurs north-east and east of the range of *A. aspera* subsp. *aspera* and, unlike that subspecies, is apparently always associated with watercourses and has been known to reproduce by layering. It has longer peduncles than the typical subspecies and also tends to have longer leaves and more numerous stamens and ovules.

Specimens from Fitzgerald River to Phillips River have noticeable crown-shaped outgrowths on the stems, although these are usually less well developed than in specimens of subsp. *aspera*. Specimens occurring further east show the least development of these outgrowths, which are widely scattered and often not very obvious.

Astartea astarteoides (Benth.) Rye, *Nuytsia* 16: 153 (2006). *Baekkea astarteoides* Benth., *Fl. Austral.* 3: 80 (1867). *Type*: inland from Cape Le Grand, [Western Australia,] *s. dat.*, *G. Maxwell s.n.* (*lecto*: K, *fide* B.L. Rye, *Nuytsia* 16: 153 (2006); *isoleccto*: MEL 72507). *Excluded syntypes*: King George Sound, [Western Australia], December 1801–January 1802, *R. Brown s.n.* (BM 000758990); King George Sound, [Western Australia], December 1821, *A. Cunningham* 135 (K, PERTH 07016042); along the coast from Bremer Bay to Esperance, [Western Australia], *G. Maxwell s.n.* (MEL 72508).

Very open spindly *shrub* when growing amongst and supported by thick vegetation, somewhat more bushy when on open ground, 0.4–1.5 m high, with a single slender stem at base; young (actively growing) stems with 4 distinct, narrow wings 0.15–0.2 mm wide; older stems not winged, pale grey throughout at first. *Leaves* mostly in fascicles on lower parts of main branchlets and often also in fascicles on newer growth, mostly widely spreading, straight or slightly recurved. *Petioles* 0.4–0.8 mm long. *Leaf blades* narrowly or very narrowly obovate from side view, 3–5 mm long, 0.5–0.9 mm wide, 0.6–1 mm thick, obtuse and often with a distinct mucro, somewhat rugose. *Inflorescence* mainly of distant pairs of flowers or with 1 or several pairs of flowers on each short, lateral branchlet. *Peduncles* usually fairly straight or somewhat recurved, 2–4 mm long. *Bracteoles* 1.4–1.7 mm long, 0.25–0.35 mm wide, with apex recurved and sometimes very shortly pointed but not or scarcely hooded; scarious margins narrow, entire. *Pedicels* 0.5–1.1 mm long. *Buds* with a somewhat 5-toothed apex. *Flowers* 4.5–6 mm diam. *Hypanthium* 1.3–1.5 mm long, 1.5–1.8 mm wide; adnate portion reticulate-pitted and often with ribs opposite the sepals; free portion 0.3–0.4 mm long. *Outer sepals* 0.35–0.6 mm long, 0.7–1 mm wide, dorsally ridged; scarious margin minutely lacinate or entire. *Petals* 1.5–1.7 mm long, pink; margin somewhat irregular. *Androecium* of 5–11 stamens, with one or no stamens opposite 1–3 of the sepals and up to 3 opposite the other sepals, usually not or only partially united into fascicles; filaments free or nearly free, 0.4–0.5 mm long; anthers *c.* 0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 6–8 per loculus. *Style* 0.8–1.1 mm long, the base immersed for 0.4–0.5 mm; stigma *c.* 0.2 mm wide. *Fruits* 3-valvate, *c.* 1.5 mm long, *c.* 2 mm diam.; hypanthium somewhat 3-lobed; undeveloped ovules/seeds dark red-brown. *Seeds* up to 4 per loculus, 0.6–0.9(–1.1) mm long, 0.35–0.5 mm thick; testa thin, golden brown to tan, often developing dark red or red-brown to black markings throughout or towards one end.

Diagnostic features. Small, single-stemmed *shrub* associated with watercourses and depressions. *Flowers* 4.5–6 mm diam.; hypanthium reticulate-pitted. *Sepals* dorsally ridged. *Petals* 1.5–1.7 mm long, pink. *Stamens* 5–11. *Staminodes* usually absent. *Ovary* 3-locular; ovules 6–8 per loculus. *Seeds* with a thin testa, mottled, smooth.

Selected specimens examined. WESTERN AUSTRALIA: Lucky Bay, Jan. 1802, *R. Brown s.n.* (BM 000758989); 12 km WNW of Esperance, on Telegraph Rd at 7.4 km E of Bates Rd or 3.1 km from intersection with South Coast Hwy, 27 Feb. 2006, *G.F. Craig* 7095 (PERTH); just N of Thistle Cove, 21 Jan. 1966, *A.S. George* 7531 (PERTH); Cape Le Grand National Park, inland from W side of road to Le Grand Beach, *c.* 0.5 km S from its junction with Frenchmans Peak turnoff, 22 Dec. 1994, *A.S. Guinness* 2436 (PERTH); 12.5 km NNE of Mt Arid, Cape Arid National Park, 30 Oct. 1990, *G.J. Keighery* 11792 (PERTH); adjacent to Helms Arboretum on the Norseman road, 17 km N of Esperance, 24 Oct. 1979, *N.S. Lander* 1066 (PERTH); Cape Le Grand Rd, 5.6 km N of National Park sign and 6.2 km N of entry gate of Cape Le Grand National Park, 4.3 km S of Merivale Rd, 11 Dec. 2003, *B.L. Rye* 231243 & *C.D. Turley* (AD, BRI, PERTH); Lake Rd, Esperance, 19 Oct. 1997, *Peter G. Wilson* 1407 & *N. Lam* (NSW, PERTH); Nares Island Beach, near parking area at the end of Nares Island Rd, 21 Oct. 1997, *Peter G. Wilson* 1414 & *N. Lam* (NSW, PERTH); Cape Le Grand National Park, 8 Nov. 1994, *A. Worz* 04.11.08.05 (PERTH).

Distribution and habitat. Occurs in near-coastal areas from just west of Esperance east to Cape Arid National Park (Figure 7B). Grows in sandy soils, mainly associated with swamps but sometimes in more rocky locations, with varied wetland-associated vegetation.

Phenology. Flowers recorded late October to January.

Conservation status. This species has a range c. 140 km long, including two large national parks, and is not considered to be at risk.

Etymology. From the genus *Astartea* and Latin ending *-oides* (like), referring to the *Astartea*-like appearance of this species, which was previously considered to belong in the genus *Baeckea*.

Affinities. *Astartea astarteoides* belongs to the *A. montana* species group and is part of the *A. glomerulosa* complex. It has a maximum of three stamens opposite each sepal and sometimes appears to have as few as five stamens per flower, in which case there are no stamens opposite at least one of the sepals. It is geographically separated from *A. glomerulosa*, but that very variable taxon includes some variants with few stamens that are very similar to *A. astarteoides*. The usually more numerous stamens in *A. glomerulosa* have a much greater tendency to be united into fascicles of two to five. *Astartea glomerulosa* tends to have longer peduncles, larger flowers and more numerous ovules. It might be more appropriate to treat these two taxa as subspecies, but the *A. glomerulosa* complex needs to be revised before any decisions are made on the status of *A. astarteoides*.

The broad disjunction between the taxa treated here as *A. astarteoides* and *A. glomerulosa* is one that is seen in a number of other species or species complexes, such as *Thryptomene saxicola* (A.Cunn. ex Hook.) Schauer and *Pimelea clavifolia*.

Co-occurring taxa. This species seems to be mostly isolated from other *Astartea* species but *A. eobalta* Rye occurs within its range. See also the discussion under *A. fascicularis*.

Notes. Robert Brown was the first collector of *A. astarteoides* in January 1802. His fruiting specimen from Lucky Bay (BM 000758989) is typical of the species. However, Bentham (1867: 80) listed an R. Brown specimen from Lucky Bay as having ‘a smaller style and stigma’ apparently referring to a different specimen (BM 000758988), which is identified on the specimen label as *Baeckea astarteoides*. The latter specimen is actually of a quite different taxon, currently known as *Baeckea* sp. Esperance (A.G. Gunness 2435).

Astartea cicatricosa Rye & Trudgen, *sp. nov.*

Typus: on the west bank of Jerdacuttup River, south of the swimming pool areas on south side of Springdale Road crossing, which is 5.5 km east of Hopetoun–Ravensthorpe Road, Western Australia, 9 December 2003, B.L. Rye 231218 (*holo:* PERTH 06585973; *iso:* CANB, K, MEL).

Astartea sp. Jerdacuttup (A. Strid 21898), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000).

Mid-dense *shrub* 0.5–1.2 m tall, single-stemmed or multi-branched from the base, sometimes layering; young (actively growing) stems reddish, not or scarcely winged; older stems often with opposite-

decussate stripes of pale grey epidermis (each stripe extending from the base of a leaf down to the next node) but sometimes uniformly pale grey. *Leaves* antrorse to widely spreading, widely spaced or in fascicles. *Petioles* 0.4–0.7 mm long. *Leaf blades* linear from side view, 6–19 mm long, 0.6–1.1 mm wide, 0.6–1 mm thick, obtuse. *Inflorescence* commonly of few pairs of flowers per branchlet but sometimes of 10 or more pairs. *Peduncles* 5–7 mm long. *Bracteoles* 0.7–2 mm long, 0.3–0.6 mm wide, reddish with pale margins, scarious, hooded, the margin entire; point absent or rarely up to 0.2 mm long. *Pedicels* 0.5–3 mm long. *Buds* obtuse, not obviously lobed. *Flowers* 7.5–11 mm diam. *Hypanthium* 1.3–1.9 mm long, c. 3 mm wide; adnate portion irregularly rugose-pitted, with minute glands in the pits; free portion 0.4–0.5 mm long. *Outer sepals* 0.7–1.0 mm long, 1.1–1.4 mm wide, smooth or scarcely ridged dorsally; scarious margin deep pink to the inside and white to the outside, entire. *Petals* 2.5–4 mm long, white or pale pink; margin almost entire. *Androecium* commonly of 40–53 stamens, in fascicles of 6–11 stamens opposite sepals and usually with a solitary stamen opposite all or some of the petals; filaments connate for up to 0.6 mm, the longest 1.3–2.2 mm long; anthers 0.2–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 9–14 per loculus. *Style* (1.4–)1.7–2.0 mm long, the basal 0.5–1 mm immersed; stigma 0.25–0.3 mm wide. *Fruits* 3-valvate, 2–2.2 mm long, 3–3.5 mm diam., usually uniformly 3-locular but occasionally with one loculus abortive; hypanthium hemispheric, scarcely 3-lobed; abortive ovules/seeds dark red-brown. *Seeds* up to 6 per loculus, 0.9–1.3 mm long, 0.4–0.5 mm wide, 0.45–0.6 mm thick; testa thick, dark red-brown at maturity, shallowly but distinctly reticulate-pitted. *Chaff pieces* somewhat compressed, dark red, often with slightly colliculate testa. (Figures 3A,B; 4B,C)

Diagnostic features. Single-stemmed or basally branched *shrub* associated with watercourses and depressions. *Flowers* 7.5–11 mm diam. *Sepals* smooth or slightly ridged. *Petals* 2.5–4 mm long, white or pale pink. *Stamens* 40–53. *Staminodes* usually absent. *Ovary* 3-locular; ovules 9–14 per loculus. *Seeds* with a thick testa, dark red-brown, reticulate-pitted.

Selected specimens examined. WESTERN AUSTRALIA: Fence Rd, 11 km N of Springdale Rd intersection, 19 Jan. 2006, *L. Ang & S. Kern* 10358 (PERTH); Woodenup Pool, 21 Nov. 1997, *M. Bennett* 25 (PERTH); c. 100 m E of Carlingup Rd, 12.1 km from Ravensthorpe–Esperance road, 22 May 1999, *M. Bennett* 473 (PERTH); Hopetoun airstrip, turnoff on road 5.8 km N of Hopetoun, 21 Oct. 2000, *M. Bennett* 638 (PERTH); 1 km S of Springdale Rd, 21 Jan. 2005, *G. Cockerton* 10521 (PERTH); 0.3 km E along track to Dunns Swamp, 4.2 km N of Hopetoun, 19 Feb. 2002, *R. Davis* 10264 (PERTH); Moolyal Creek reserve near Mt Short, N of Ravensthorpe, 11 Mar. 1988, *S.D. Hopper* 6342 (PERTH); near crossing of Yallobup Creek on Mason Bay Rd, 1.0 km S of Springdale Rd, 9 Dec. 2003, *B.L. Rye* 231222 (AD, BRI, PERTH); 33 km along Springdale Rd, off Hopetoun–Ravensthorpe Rd, 2 Jan. 1983, *A. Strid* 21898 (PERTH).

Distribution and habitat. Extends from the upper Jerdacuttup River (north of Ravensthorpe Range) south to near Hopetoun and east to Lake Shaster (Figure 8A). Recorded along watercourses and on the margins of swamps, always in very damp locations, with varied other species associated with wetlands, and often with *Melaleuca* species, such as *M. cuticularis*, dominant.

Phenology. Flowers mainly from late October to January, also recorded February, April and May.

Conservation status. Not currently considered to be at risk. It is geographically restricted, with a known range c. 75 km long, but appears to be fairly common within that area.

Etymology. From the Latin *cicatricosus* (full of scars), referring to the numerous pits over the surface of the seeds.

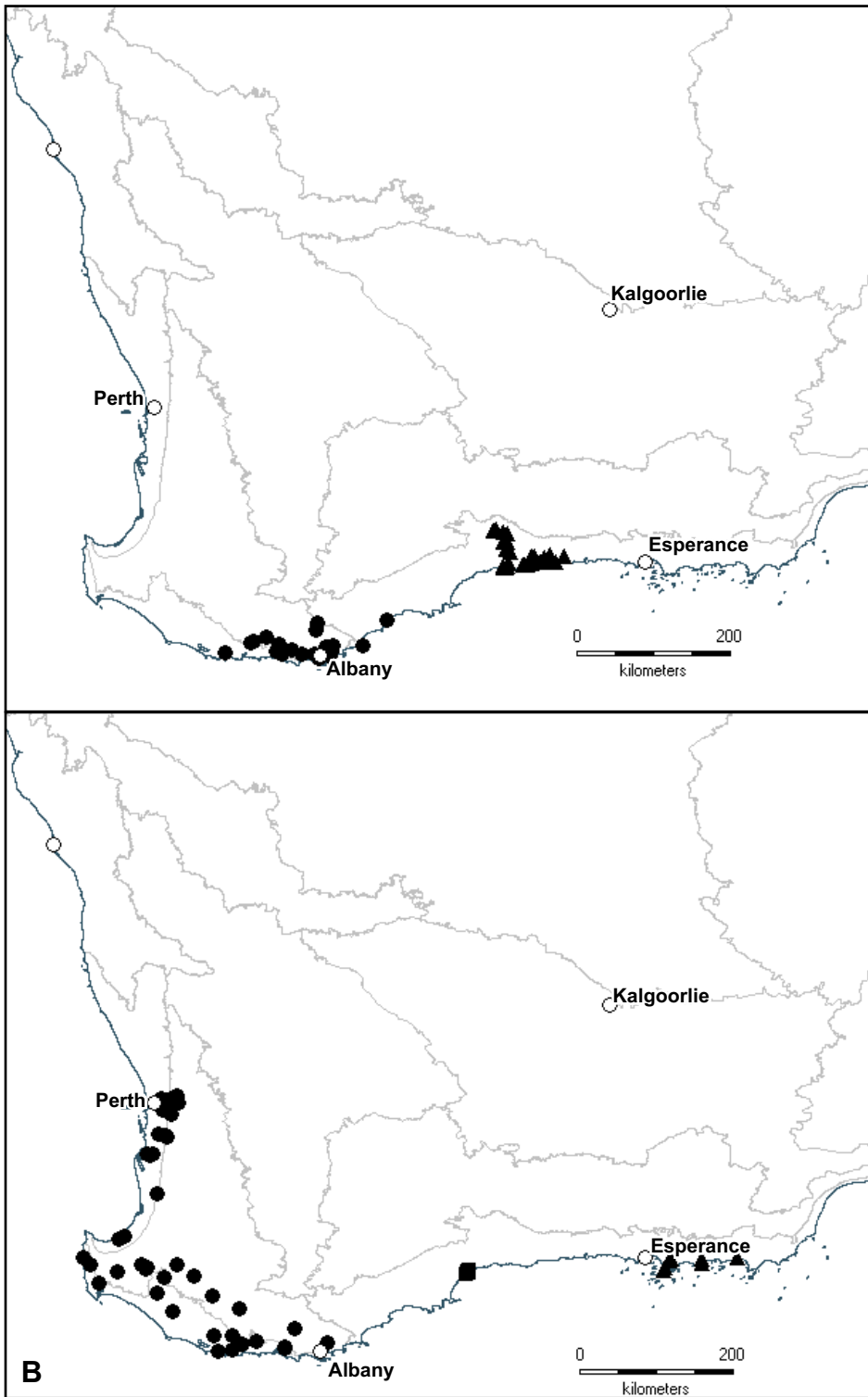


Figure 8. Distributions of *Astartea* species. A – *A. cicatricosa* (▲), *A. corniculata* (●); B – *A. decemcostata* (■), *A. eobalta* (▲), *A. leptophylla* (●).

Affinities. This species belongs to the *A. aspera* group, in which the mature viable seeds have a thick testa. It differs from the few other members of this group in having more numerous stamens, usually also with a single stamen opposite all or some of the petals, and also in having smoother sepals.

Co-occurring taxa. *Astartea cicatricosa* overlaps in range with *A. reticulata* but probably tends to occur in wetter habitats. The two species have occasionally been found in close proximity (G. Cockerton pers. comm.). For example, a single specimen of *A. reticulata* was found near a population of *A. cicatricosa*, perhaps transported there originally by roadworks, while at another locality a single specimen of *A. cicatricosa* was found near a population of *A. reticulata*. No hybrids have been confirmed. *Astartea cicatricosa* can normally be distinguished readily by its smoother sepals, more numerous stamens, smaller anthers that are almost square in outline, and uniformly dark seeds. It probably also tends to have paler flowers.

Notes. Most specimens are single-stemmed at the base but one from a rocky riverbank was found to have layered. Specimens occurring along watercourses generally tend to have larger leaves and flowers than those associated with swamps. Typical specimens (including all those known from the banks of watercourses and also many from swamps) have numerous stamens, with a single stamen usually present opposite some or all of the petals as well as fairly large fascicles opposite the sepals. Some of the specimens from the eastern part of the range have fewer stamens and none opposite the petals, but no consistent differences have been found so far to suggest that more than one taxon should be recognised. *A. Strid* 21898 has smaller leaves and flowers than other specimens and occasional abortive loculi, suggesting that it may be a depauperate specimen in a bad season.

The stamen fascicles may be cleft, sometimes widely, at the centre into two more or less equal parts opposite some, but not all, of the sepals.

Astartea corniculata Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 115 (1844). *Type:* 'In subturfosarenosis planitiae prope vicum Albany', [somewhat peaty sand on plain near Albany, Western Australia], 6 January 1840, *L. Preiss* (Herb. Preiss No.) 163 (*holo:* LD; *iso:* MEL 2147399).

Slender *shrub* 0.3–0.5 m high, 0.5–0.8 m wide, producing multiple slender stems from a thick lignotuber; young (actively growing) stems brown or red-brown and very narrowly 4-winged; older stems uniformly pale grey. *Leaves* mostly in fascicles on very short lateral branchlets, spreading. *Petioles* 0.3–0.7 mm long. *Leaf blades* narrowly obovate to somewhat clubbed from side view, 2.5–4.5 mm long, 0.3–0.5 mm wide, 0.5–0.7 mm thick, obtuse or narrowly obtuse. *Inflorescence* usually of several to 10 spaced pairs of flowers along a leafy branchlet, rarely with flowers more clustered. *Peduncles* 1.5–3.5 mm long. *Bracteoles* incurved, sometimes leaf-like but usually more scarious, broadest towards the apex, 1.2–2 mm long, 0.3–0.4 mm wide, the somewhat hooded apex sometimes with a dorsal point up to 0.2 mm long. *Pedicels* 1.3–1.8 mm long. *Buds* 5-horned. *Flowers* (4–)4.5–6.5 mm diam. *Hypanthium* 0.8–1 mm long, 1.5–1.8 mm wide; adnate portion minutely rugose-glandular but not obviously pitted; free portion *c.* 0.3 mm long. *Outer sepals* 0.9–1.4 mm long (including the horn), 1.0–1.5 mm wide, dorsally distinctly to very prominently horned; scarious margin entire or minutely irregularly indented; horn 0.4–1 mm long. *Petals* 1.7–2.5 mm long, white or pale pink; margin denticulate. *Androecium* usually of 15–20 stamens in fascicles of 2–5 opposite the sepals, rarely of far fewer stamens with none or only 1 opposite the sepals; filaments connate for up to 0.4 mm, the longest 0.8–1.2 mm long; anthers 0.2–0.3 mm long; staminodes absent or rare. *Ovary* usually 2-locular, with adaxial and abaxial loculi of similar or differing sizes, if 3-locular then one loculus sometimes distinctly exceeding the other two; ovules 2–5 per loculus. *Style* 1.2–1.6 mm long, the basal 0.25–0.4 mm immersed; stigma *c.* 0.2 mm wide. *Fruits* 2- or 3-valvate, 1–1.1 mm long, 1.7–2 mm wide; hypanthium somewhat 2-

or 3-lobed; undeveloped ovules/seeds dark red. *Seeds* up to 3 per loculus, irregularly ovoid to very broadly reniform, 0.65–0.8 mm long, 0.4–0.55 mm thick; testa thin, off-white and with irregular red markings at first, becoming more generally reddish.

Diagnostic features. Low, lignotuberous *shrub* occurring in winter-wet depressions. *Flowers* 4–6.5 mm diam. *Sepals* prominently horned. *Petals* 1.7–2.5 mm long, white or pale pink. *Stamens* usually 15–20. *Staminodes* usually absent. *Ovary* 3-locular; ovules 2–5 per loculus. *Seeds* with a thin testa, mottled, smooth.

Selected specimens examined. WESTERN AUSTRALIA: N of Hunwick Rd, 11 km ENE of Denmark, 7 Mar. 1990, *A.R. Annels* 1110 (PERTH); Collingwood Rd East, 20 Feb. 1980, *E.J. Croxford s.n.* (CANB *n.v.*, K *n.v.*, PERTH); swamp beside track along W fence, gravel reserve, Howell Rd, off South Coast Hwy, W of Albany, 20 Jan. 1996, *E.J. Croxford* 7225 (PERTH); Attwell Park Reserve, Reddale Rd off Albany Hwy, 6 km NW of Albany, 22 Feb. 1997, *E.J. Croxford* 7725 (PERTH); down Gull Rock Rd, 5 km WNW of Nanarup, 12 Dec. 1996, *R. Davis* 1802 (PERTH); Denmark River, 20 Feb. 1922, *C.A. Gardner* 1248 (PERTH); King George Sound, Albany, Jan.–Feb. 1854, *W.H. Harvey s.n.* (PERTH); 15 km NE Albany on Hassel Hwy, 12 Dec. 1982, *K.H. Rechinger* 60405 (PERTH); Albany, 25 Feb. 1955, *R.D. Royce* 5014 (PERTH); on track into Rudgyard Nature Reserve, 0.15 km W of W end of Crusoe Beach Rd, 22 Jan. 2003, *B.L. Rye* 230131, *R.W. Hearn & B.G. Hammersley* (PERTH); Ledge Beach Rd, 1.0 km S of Ledge Point Rd, Gull Rock National Park, 8 Jan. 2010, *B.L. Rye* 290150 (PERTH); W across inlet from Walpole township, *c.* 60 m from inlet edge, 13 Feb. 1994, *M.E. Trudgen* 12043 (PERTH).

Distribution and habitat. Occurs along the south coast, mainly from Denmark east to near Nanarup, but with an isolated record from Walpole (Figure 8A). Recorded in peaty, sandy swamps, occurring in very low shrubland intermixed with sedges and other wetland plants, in similar very damp habitats to those occupied by *A. arbuscula*, and sometimes occurring intermixed with that species.

Phenology. Flowers recorded from mid-December to early March.

Conservation status. Not currently considered to be at risk. It occurs in several conservation reserves and most of its populations are fairly large.

Etymology. From the Latin *corniculum* (little horn), in reference to the prominent horn on the small sepals.

Affinities. Since it has variegated seeds, *A. corniculata* is included in the *A. montana* species group, differing from most members of that group in having a relatively smooth hypanthium and prominently horned sepals. Another species with these hypanthium and sepals characters, *A. schaueri*, can be distinguished from *A. corniculata* by its larger habit, leaves and flowers, and its more numerous stamens and ovules. *Astartea corniculata* differs from almost all other species in that its ovary is usually functionally 2-locular. Some specimens are predominantly 3-locular but have 2-locular flowers as well.

Co-occurring taxa. This species normally occurs with other *Astartea* species in swampy habitats along the part of the south coast with the highest rainfall. The co-occurring species include *A. glomerulosa*, which tends to flower earlier than *A. corniculata*, and several members of the *A. scoparia* group. One species of the latter group, *A. arbuscula*, appears to be able to hybridise with *A. corniculata* (see *Presumed hybrids* below).

Notes. The isolated Walpole collection (*M.E. Trudgen* 12043) of *A. corniculata* has far fewer stamens than all other specimens, apparently with only one stamen or none opposite each sepal as in *A. arbuscula* and *A. transversa*. The taxonomic status of the Walpole variant of *A. corniculata* is unclear as it is known only from one collection. More fieldwork is needed in the poorly surveyed area surrounding Walpole, and extending eastwards to determine whether the apparent disjunction between Walpole and Denmark is real.

Astartea decemcostata Rye, *sp. nov.*

Typus: Fitzgerald River National Park, Western Australia [precise locality withheld for conservation reasons], 27 November 2002, *M. Hislop* 2867, *S. Barrett* & *J.A. Cochrane* (*holo:* PERTH 06236510; *iso:* CANB, K, MEL).

Astartea sp. Barren Range (*S. Barrett* 340.5), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Shrub 0.7–1.8 m high, 0.5–1.5 m wide, single-stemmed at the base; young (actively growing) stems narrowly or very narrowly winged; older stems with thickened pale grey epidermis below each node and more reddish layer between, soon becoming largely brown but retaining the pale grey strips below each node. *Leaves* mostly in fascicles (except on young, rapidly growing stems), slightly incurved to slightly outcurved. *Petioles* 1–1.5 mm long, poorly defined. *Leaf blades* linear in outline, 8–12 mm long, 0.4–0.5 mm wide, 0.5–0.6 mm thick, acute, somewhat wrinkled-rugose. *Inflorescence* commonly of 2–4 pairs of flowers per main branchlet. *Peduncles* 3–5 mm long. *Bracteoles* 3–4 mm long, 0.35–0.5 mm wide, with a hooded apex, acute or with a slight terminal point; scarious margins incurved, narrow. *Pedicels* 1.5–2.5 mm long. *Buds* 5-toothed to 5-lobed. *Flowers* 7.5–10 mm diam. *Hypanthium* 1.5–2.5 mm long, up to *c.* 3 mm wide, usually distinctly broadly 5–10-ribbed (at least some flowers 10-ribbed); adnate portion gland-dotted but not very reticulate-pitted; free portion 0.6–0.8 mm long. *Outer sepals* 0.5–0.8 mm long, 1–1.4 mm wide, the outer ones strongly ridged to shortly horned; scarious margin narrow; horn up to 0.3 mm long. *Petals* 3–4 mm long, pale or very pale pink; margin almost entire. *Androecium* of 30–34 stamens, in fascicles of 4–9 opposite the sepals; filaments connate for up to 0.6 mm, the longest 1–1.3 mm long; anthers 0.2–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 7–9 per loculus. *Style* 1.3–1.5 mm long, the basal *c.* 0.5 mm immersed; stigma *c.* 0.3 mm wide. *Fruits* 3-valvate, *c.* 2 mm long, *c.* 3 mm diam.; hypanthium 3-lobed. *Seeds* irregularly ovoid, 0.7–0.8 mm long, *c.* 0.5 mm thick; testa moderately thick, golden brown to greyish brown, with a dark reticulate pattern resulting from darkened cell margins or mottled, with the cell margins slightly raised. *Chaff pieces* dark red-brown. (Figure 3C)

Diagnostic features. Single-stemmed *shrub*, growing on rocky hillsides. *Flowers* 7.5–10 mm diam.; hypanthium commonly 10-ribbed. *Outer sepals* strongly ridged to very shortly horned. *Petals* 3–4 mm long, pale or very pale pink. *Stamens* 30–34. *Staminodes* usually absent. *Ovary* 3-locular; ovules 7–9 per loculus. *Seeds* with a moderately thick testa, mottled.

Selected specimens examined. WESTERNAUSTRALIA [localities withheld for conservation reasons]: 14 Nov. 1995, *S. Barrett* 340.5 (PERTH); 28 Nov. 2002, *M. Hislop* 2886, *S. Barrett* & *J.A. Cochrane* (PERTH); 29 Nov. 2002, *M. Hislop* 2888, *S. Barrett* & *J.A. Cochrane* (PERTH).

Distribution and habitat. Known from gullies on the lower slopes of two peaks in the Barren Range, occurring in winter-wet brown or grey sandy soil over quartzite in mallee woodlands or in shrublands

(Figure 8B). Associated species recorded at one or more of the sites include *Eucalyptus conferruminata*, *Agonis obtusissima*, *Allocasuarina trichodon*, *Hakea hookeriana*, *Acacia myrtifolia* and *Baumea preissii*.

Phenology. Flowers from mid-November to early December.

Common name. Barrens Astartea.

Conservation status. Recently listed as Priority Two under DEC Conservation Codes for Western Australian Flora under the name *A. sp.* Barren Range (S. Barrett 340.5) (Western Australian Herbarium 1998–). Known from three populations in a very small area within a large national park.

Etymology. From the Latin *decem* (ten) and *costa* (rib), referring to the tendency for the hypanthium to be 10-ribbed.

Affinities. Belongs to the *A. aspera* group and shows greatest similarity to *A. reticulata*, differing in its longer petioles and leaf blades and usually 10-ribbed hypanthium. The two species overlap in range but occupy different habitats. The seed testa of *A. decemcostata* and *A. reticulata* lacks the uniformity of dark colouring found in the other members of the *A. aspera* group and is not as thick, but has thicker cell margins than in other *Astartea* groups.

Co-occurring taxa. Not recorded with any other *Astartea* species.

Notes. *Astartea decemcostata* is single-stemmed and easily killed by fire (M. Hislop pers. comm.) but regenerates readily from seed. Probably the most notable characteristic of *A. decemcostata* is its multi-ribbed hypanthium (Figure 3C). The hypanthium has five prominent ribs opposite the sepals and up to five, usually not as well developed ones, opposite the petals, a character that distinguishes it from all other species of *Astartea*.

Astartea eobalta Rye, *sp. nov.*

Typus: Cape Le Grand, Western Australia [precise locality withheld for conservation reasons], 9 April 1966, E.M. Scrymgeour 440 (*holo*: PERTH 06172628).

Astartea sp. eastern swamps (A.G. Gunness 2434), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Spindly open *shrub* 0.4–2.5 m tall, single-stemmed at the base and with slender spreading branches; young (actively growing) stems reddish, narrowly or very narrowly 4-winged; older stems with a pale grey epidermis which splits to reveal a reddish brown under-layer. *Leaves* erect to moderately spreading, widely spaced on some upper flowering stems but often in fascicles elsewhere, slightly incurved to slightly recurved. *Petioles* 0.5–1.3 mm long, poorly defined. *Leaf blades* narrowly obovate to almost linear from side view, 5–12 mm long, 0.4–0.8 mm wide, 0.6–0.8 mm thick, acute, somewhat wrinkled-rugose, often with a minute recurved apical point up to 0.3 mm long. *Inflorescence* commonly of 3–8 pairs of flowers per branchlet. *Peduncles* 1.5–3.5 mm long. *Bracteoles* 1.3–3 mm long, 0.3–0.5 mm wide, with a hooded and dorsally pointed apex; scarious margins *c.* half as wide as bracteole or broader, entire; point up to 0.4 mm long. *Pedicels* 1.5–3.5 mm long. *Buds* 5-toothed to 5-lobed. *Flowers* 7–8.5 mm diam. *Hypanthium* 1.8–2.7 mm long, up to *c.* 3 mm wide; adnate portion usually somewhat broadly 5-ribbed, gland-dotted; free portion 0.4–0.6 mm long. *Outer sepals* 0.5–0.6 mm long,

0.8–1.2 mm wide, strongly ridged to shortly horned; scarious margin entire; horn up to 0.4 mm long. *Petals* 2–3.2 mm long, pale pink or white; margin minutely lacinate. *Androecium* of 21–31 stamens, in fascicles of 3–8 opposite the sepals; filaments connate for up to 0.4 mm, the longest 0.7–1 mm long; anthers *c.* 0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 8–14 per loculus. *Style* 1.4–1.8 mm long, the basal 0.5–0.8 mm immersed; stigma 0.3–0.35 mm wide. *Fruits* 3-valvate, 1.6–2 mm long, 1.9–3 mm diam.; hypanthium somewhat 3-lobed; undeveloped ovules/seeds dark red-brown. *Seeds* commonly up to 5 per loculus, 0.7–1.1 mm long, 0.4–0.5 mm thick; testa thin, pale golden brown to greyish brown, uniformly coloured, smooth.

Diagnostic features. Single-stemmed or basally branched *shrub* associated with winter-wet depressions. *Flowers* 7–8.5 mm diam. *Outer sepals* strongly ridged to shortly horned. *Petals* 2–2.7 mm long, pale pink or white. *Stamens* 21–31. *Staminodes* usually absent. *Ovary* 3-locular; ovules 8–14 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERNAUSTRALIA [localities withheld for conservation reasons]: 22 Dec. 1994, *A.G. Gunness* 2434 (PERTH); 22 Dec. 2005, *R.M. Hoggart* 3/1205 (PERTH); 11 Dec. 2003, *B.L. Rye* 231244 & *C.D. Turley* (PERTH); 3 Jan. 1983, *A. Strid* 21907 (PERTH).

Distribution and habitat. Recorded from north of Cape Le Grand east to Dolphin Cove, in seasonal swamps or rarely minor creeklines with sandy soils (Figure 8B). Associated vegetation in the south-west of the known range was recorded as coastal heath and sedgeland, with *A. eobalta* and occasional *Banksia occidentalis* being emergent. The locality sampled in the current study had grey-brown sand on a rise above a swamp, with *Eucalyptus occidentalis* (Swamp Yate) trees over *Melaleuca cuticularis* and *Acacia cyclops* over sedgeland, indicating that the species is likely to be somewhat salt-tolerant.

Phenology. Flowers mainly from late October to January, also recorded in April.

Conservation status. Recently listed as Priority Two under DEC Conservation Codes for Western Australian Flora, under the name *A. sp. eastern swamps* (*A.G. Gunness* 2434) (Western Australian Herbarium 1998–). Attempts in 2004 to relocate the species at several road-verge localities were unsuccessful except for one locality where a single plant was found. The species has also been recorded in Cape Le Grand National Park and Cape Arid National Park, its known range *c.* 80 km long.

Etymology. From the Greek *eos* (east) and *balte* (swamp) as this species is associated with wetlands in the eastern part of the range of the genus.

Affinities. This species has been confused with *A. fascicularis*, a species restricted to coastal granite, which can be readily distinguished by the more prominent grey thickenings present on its stems, its more numerous stamens, the presence of staminodes, and its higher ovule number.

Astartea eobalta is probably like *A. decemcostata* and *A. reticulata* in having a single-stemmed habit, but the former differs in its 10-ribbed hypanthium and habitat, while the latter differs in having fewer stamens; both have a thicker testa on their seeds.

Co-occurring taxa. This species occurs within the range of *A. astarteoides* but appears to be geographically isolated from all other species. The two species also have similar flowering times but *A. eobalta* probably tends to occur in damper microhabitats.

Notes. Further collections are needed to confirm the habit of this species, as only one plant has been examined to check for a lignotuber, and to determine whether the variation within it indicates that more than one taxon should be recognised. Eastern specimens tend to have smaller bracteoles than western ones and a greater tendency for leaves to be in fascicles. *K.R. Newbey* 167 appears to have the shortest petals and stamens, and its seeds are shorter and broader than usual.

Astartea fascicularis (Labill.) DC., *Prod.* 3: 210 (1828). *Melaleuca fascicularis* Labill., *Nov. Holl. Pl.* 2, 29–30, tab. 170 (1806). *Baeckea fascicularis* (Labill.) Nied. in A. Engler & K. Prantl, *Nat. Pflanzenfam.* III, 7: 99 (1893). *Type:* ‘in capite Van-Diemen’ [probably actually collected on Observatory Island, Archipelago of the Recherche, Western Australia], 11–18 December 1792, *J.J.H. de Labillardière s.n.* (*holo:* FI *n.v.*, illustration seen).

Illustration. J.J.H. de Labillardière, *Nov. Holl. Pl.* 2: 29–30, t. 170 (1806) [as *Melaleuca fascicularis*].

Dense *shrub* commonly 0.8–1.5 m when wind-pruned but up to 3 m high in more protected sites, single-stemmed or multi-branched at ground level and layering when opportunity arises; young (actively growing) stems pale red-brown to deep reddish, with narrow ridges or wings to 0.3 mm wide; older stems prominently ridged and pale grey, later developing opposite-decussate stripes of pale grey epidermis (each stripe extending from the base of a leaf down to the next node) alternating with reddish brown stripes, the pale grey epidermis prominently thickened directly below each leaf. *Leaves* slightly curved, mostly in fascicles. *Petioles* 0.8–2 mm long. *Leafblades* very narrowly obovate from side view, 5–12 mm long, 0.4–0.6 mm wide, 0.4–0.8 mm thick, obtuse. *Inflorescence* of several to many pairs of flowers along the branchlets. *Peduncles* 2–5 mm long. *Bracteoles* 1.3–1.7 mm long, 0.4–0.6 mm wide, the hooded apex sometimes with a small dorsal point up to 0.2 mm long; scarious margins narrow, entire. *Pedicels* 1.6–3.5 mm long. *Buds* with apex fairly flat to distinctly 5-lobed. *Flowers* 8–11 mm diam. *Hypanthium* 1.5–3 mm long, 2.5–3.7 mm wide; adnate portion often broadly 5-ribbed, fairly smooth but with oil glands often slightly protruding; free portion 0.6–1 mm long. *Outer sepals* 0.8–1.2 mm long, 1.6–2.2 mm wide, scarcely to prominently ridged dorsally; scarious margin entire. *Petals* 2.5–4 mm long, white or rarely pale pink; margin entire or almost so. *Androecium* of 30–44 stamens and 10 or sometimes fewer staminodes, in fascicles, with 5–10 stamens per fascicle; filaments connate for up to 0.5 mm, the longest 0.9–2 mm long; anthers 0.2–0.25 mm long; staminodes located at the margins of each fascicle and often distinctly separated from the stamens, either attenuate or with a sterile reduced anther, occasionally flattened and somewhat petaline, usually distinctly longer than the stamens. *Ovary* 3-locular; ovules 14–23 per loculus. *Style* 1.4–2.8 mm long, the basal 0.4–0.7 mm immersed; stigma up to *c.* 0.4 mm wide. *Fruits* 3-valvate, 2–2.4 mm long, 2.5–3 mm diam.; hypanthium somewhat 3-lobed; abortive ovules/seeds numerous, dark brown. *Seeds* much fewer than the chaff pieces, up to 5 per loculus, not flattened, 0.8–1.1 mm long, 0.3–0.45 mm wide, 0.4–0.6 mm thick; testa thin, pale brown to golden brown, fairly smooth.

Diagnostic features. Single-stemmed or multi-branched *shrub* associated with granite. *Flowers* 8–11 mm diam. *Sepals* smooth to prominently ridged. *Petals* 2.5–4 mm long, white or pale pink. *Stamens* 30–44. *Staminodes* occurring on the margins of the fascicles. *Ovary* 3-locular; ovules 14–23 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERN AUSTRALIA: Mondrain Island, 19 Nov. 2002, *S. Comer* 38 (PERTH); Middle Island, 1818, *A. Cunningham* 17 (PERTH); Thistle Cove, Cape Le Grand National Park, 27 Nov. 1985, *D.B. Foreman* 1284 (NSW, PERTH); N side of Mt Le Grand, 12 Dec. 1960, *A.S. George* 2229 (PERTH); Woody Island, 18 Nov. 1998, *M. Hislop* 1226 (CANB, PERTH); Middle Island, 4 Nov. 2003, *R.J. Powell s.n.* (PERTH); Wilson Island, 1 Feb. 1960, *R.D. Royce* 6157

(PERTH); Thistle Cove, Cape Le Grand National Park, 11 Dec. 2003, *B.L. Rye* 231246 & *C.D. Turley* (AD, BRI, PERTH); along walk trail between Le Grand Beach and Hellfire Bay, 6 Nov. 1982, *A. Strid* 21207 (PERTH); Woody Island, Esperance, 12 Dec. 1995, *C.D. Turley* & *R. Bruhn* 28/1295 (PERTH).

Distribution and habitat. This species occurs at the south-eastern extreme of the range of the genus, being widespread in the Archipelago of the Recherche, extending from Observatory Island east to Middle Island, also occurring on the mainland coast of the Cape Le Grand National Park (Figure 9A). It grows on somewhat elevated sites with granite, often in exposed, coastal, wind-pruned vegetation but also occurring in well protected sites on the larger islands in dense scrub.

Phenology. Flowering is recorded from early November to February.

Conservation status. This species is well protected, occurring in a large national park and the Archipelago nature reserve.

Etymology. From the Latin *fasciculus* (small fascicle), the protologue noting that both the leaves and stamens are in fascicles.

Common name. Recherche *Astartea*.

Type details. No collections have been made of *A. fascicularis* on Observatory Island since 1792, when the island was used as a refuge from bad weather by two French vessels on Labillardière's expedition (Duyker 2003). However, the species does still occur on the island and has been photographed there by Coral Turley (pers. comm.).

Affinities. The three species that are found close to the range of *A. fascicularis* all occur mainly in winter-wet swamps rather than on granite; of these *A. eobalta* shows the greatest similarities but differs as discussed under that species.

Astartea fascicularis has been confused with *A. montana*, which is also found on rocky locations and regularly has staminodes on the margins of the stamen fascicles. That species occurs in a quite different region, being endemic to the Stirling Range area, and differs in its reticulate-pitted hypanthium and mottled seeds.

Co-occurring taxa. Populations occurring on the islands of the Archipelago of the Recherche are completely isolated from other *Astartea* species. On the mainland, *A. fascicularis* also apparently occurs alone, although it has been recorded not far from *A. astarteoides* at Thistle Cove. *Astartea astarteoides* was collected from the edge of a swamp below a granite hill just north of Thistle Cove (*A.S. George* 7531) whereas *A. fascicularis* was found on exposed granite directly on the coast of the cove (e.g. *Peter G. Wilson* 1627 & *G.M. Towler*).

Notes. Despite its extensive distribution on islands, *A. fascicularis* seems to be very restricted in its distribution on the mainland. One characteristic of this species rarely seen in other members of the genus is the strongly developed striping of its older stems with thick, opposite-decussate stripes topped with pale grey epidermis.

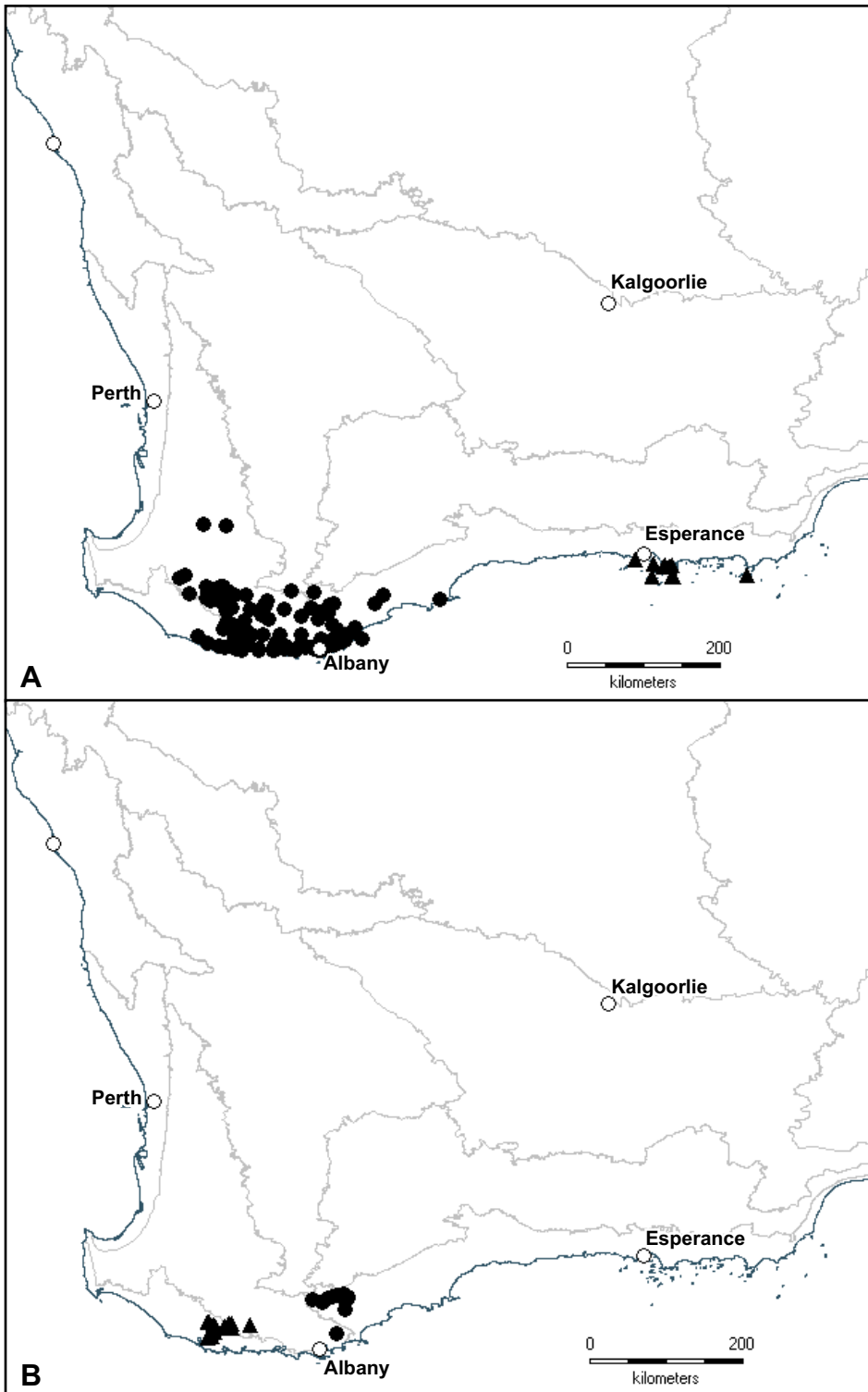


Figure 9. Distributions of *Astartea* species. A – *A. fascicularis* (▲), *A. gomerulosa* (●); B – *A. granitica* (▲), *A. montana* (●).

Astartea glomerulosa Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 115 (1844). *Type*: 'In regionibus interioribus Sinus Regis Georgii III' [inland from King George Sound, Western Australia], 8 November 1840, *L. Preiss* (Herb. Preiss No.) 162 (*holo*: LD).

Astartea sp. long stalks (D. Foreman 1490), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002).

Illustration. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002) [as *Astartea* sp. long stalks (D. Foreman 1490)].

Shrub commonly 0.3–1 m high, single-stemmed at the base, with a tap root and several horizontal main stems radiating just below the soil surface; young (actively growing) stems with 4 distinct narrow wings up to *c.* 0.2 mm wide; older stems not winged, pale grey throughout at first. *Leaves* mostly in fascicles on the lower parts of main branchlets and often also fasciculate on newer growth, mostly widely spreading, straight or slightly recurved. *Petioles* 0.4–0.8 mm long. *Leafblades* narrowly or very narrowly obovate from side view, 2–6 mm long, 0.5–0.8 mm wide, 0.7–1 mm thick, obtuse and often with a distinct mucro, somewhat rugose. *Inflorescence* mainly of distant pairs of flowers or with 1 or several pairs of flowers on each short lateral branchlet. *Peduncles* usually fairly straight or somewhat recurved, 2–10 mm long. *Bracteoles* 1–2.1 mm long, 0.3–0.55 mm wide, with apex erect and usually distally hooded; scarious margins narrow, entire; point absent or up to 0.2 mm long. *Pedicels* 1–2.5 mm long. *Buds* often with a somewhat 5-toothed apex. *Flowers* usually 5–8 mm diam. *Hypanthium* 1.2–1.5 mm long, 1.8–2.3 mm wide; adnate portion usually distinctly reticulate-pitted; free portion 0.4–0.5 mm long. *Outer sepals* 0.7–1 mm long, 1–1.6 mm wide, somewhat dorsally ridged to very shortly horned; scarious margin minutely lacinate or entire. *Petals* 1.5–3 mm long, pale to medium pink; margin somewhat irregular. *Androecium* of 15–21 stamens, in groups of 2–5 stamens opposite at least three of the sepals (sometimes with 2 distinct, 2-staminate fascicles opposite a single sepal) and often solitary opposite one or two sepals; filaments connate for up to 0.6 mm, the longest 0.5–1 mm long; anthers 0.2–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 5–9 per loculus. *Style* 0.8–1.4 mm long, the basal 0.4–0.5 mm immersed; stigma 0.25–0.4 mm wide. *Fruits* 3-valvate, 1.4–1.6 mm long, 2–2.5 mm wide; hypanthium hemispheric, scarcely 3-lobed; abortive ovules dark red-brown. *Seeds* often several per loculus, scarcely flattened laterally, 0.7–1 mm long, 0.35–0.45 mm thick; testa thin, golden brown and with dark reddish to ± black minute markings, smooth. (Figure 1C)

Diagnostic features. Single-stemmed *shrub* mainly associated with winter-wet depressions. *Flowers* usually 5–8 mm diam.; hypanthium reticulate-pitted. *Sepals* slightly ridged to very shortly horned. *Petals* 1.5–3 mm long, pale to medium pink. *Stamens* 15–21. *Staminodes* usually absent. *Ovary* 3-locular; ovules 5–9 per loculus. *Seeds* with a thin testa, mottled, smooth.

Selected specimens examined. WESTERNAUSTRALIA: near Mitchell River crossing on old Denmark–Mount Barker road, 23 Oct. 1991, *A.R. Annels* 1780 (PERTH); behind the first dune, Broke Inlet, 19 Dec. 1994, *A.R. Annels* 5238 & *R.W. Hearn* (PERTH); Bowelling–Duranillin Rd, near Bowelling, 27 Nov. 1994, *V. Crowley* 12 (PERTH); Gledhow–Old Denmark Rd, 28 Nov. 1978, *E.J. Croxford* 57 (PERTH); *c.* 40 km W of Denmark, 0.5 km N of South Western Hwy, 5 Dec. 1985, *D.B. Foreman* 1490 (NSW, PERTH); Parry Inlet, 13 Nov. 1960, *C.A. Gardner* 13039 (PERTH); Peaceful Bay, adjacent to Parry Inlet, 24 Nov. 1990, *N. Gibson* & *M. Lyons* 110 (PERTH); upper Blackwood River, 10 Dec. 1877, *F. Mueller s.n.* (MEL 76017); N side of Lake View Rd, 3.5 km W of Northern Rd and 0.3 km W of Parkinson Rd, 2 Dec. 2002, *B.L. Rye* 221210 & *R.W. Hearn* (PERTH); Walpole–Nornalup National Park, 15 Dec. 1991, *J.R. Wheeler* 2955 (PERTH).

Distribution and habitat. Extends from near Bowelling south to Broke Inlet and east to Pallinup River, in deep, sandy soils around the drier margins of swamps and less commonly in shallow soil overlying laterite or granite (Figure 9A). Paperbarks are usually present.

Phenology. Flowers mainly from October to mid-December, with some earlier records from August to September and with a few flowers sometimes present on a few plants in January.

Conservation status. Not currently considered to be at risk, as it has numerous populations spread over a relatively large range.

Etymology. From the Latin *glomeris* (small ball of yarn) and *ulosa* (abounding in), presumably in reference to the ball-like fascicles of short leaves up the stems of the type specimen.

Common name. Early Astartea.

Affinities. Its closest relative is *A. astarteoides*, these two species forming the *A. glomerulosa* complex. See the notes under *A. astarteoides*.

Co-occurring taxa. *Astartea glomerulosa* has been recorded with *A. scoparia* and a number of other *Astartea* species, but tends to occupy drier microhabitats and to flower earlier than the co-occurring species.

Notes. The holotype of *A. glomerulosa* is only a fragment with two short branchlets both broken off so their full length is uncertain, with an additional very short unbroken piece possibly from a very short lateral branchlet. This material has small leaves and flowers similar to those of some of the single-stemmed specimens from inland of Albany, such as *B.L. Rye* 221253. Many of the PERTH specimens differ in having fewer stamens and/or actively growing branchlets with four narrow wings whereas the type appears not to be growing at all, but this may be because the tips have been broken off the type specimen to reduce it to carrying size. Only one flower is open on the specimen, and this appears to have stamens mostly in fascicles of three or four, although one partially hidden fascicle may have only two stamens.

As this species lacks a lignotuber it is vulnerable to fire, but it reproduces readily by seed following fires and other disturbances. It is usually an erect spindly shrub at first, becoming more bushy with age but still with erect to spreading flowering branchlets. A few specimens have a distinctive, weeping habit, but once pressed look very similar to the other specimens. Weeping habit is also found spasmodically amongst other species of *Astartea* and within species of other genera so does not necessarily have any taxonomic significance.

One of the most variable characters within this species, as currently defined, is its peduncle length (or overall stalk length if the pedicel is included). Usually the pedicel is much shorter than the peduncle but if the peduncle is relatively short then the pedicel may sometimes be longer than usual and the two stalks are then of about the same length.

A variant that has fewer stamens than in the above description occurs mainly from Albany to Cheyne Bay, but it apparently intergrades with the variant previously known as *A. sp. long stalks* (D. Foreman 1490).

An entity known as *A. sp. Lake Muir* (B.L. Rye 230128 & R.W. Hearn) differs from the above description in having smaller seeds, 0.5–0.7 mm long. It is restricted to a small area surrounding Lake Muir, occurring in a damper microhabitat and flowering later than the typical *A. glomerulosa* populations that occur in the same general area, and having a more delicate overall appearance. While this taxon appears from field surveys to be a distinct species it cannot be readily distinguished from the many variants of *A. glomerulosa s. lat.* occurring in other areas and the whole complex needs further work to determine how many species should be recognised. In the interim, *A. sp. Lake Muir* is retained on Western Australia's vascular plant census and is listed as having a Priority Two conservation status (Smith 2012).

Astartea granitica Rye & Trudgen, *sp. nov.*

Typus: north of Walpole, Western Australia [precise locality withheld for conservation reasons], 20 December 1995, *A.R. Annels* 5645 (*holo*: PERTH 04247515; *iso*: CANB, K, MEL).

Astartea sp. Mt Johnston (A.R. Annels 5645), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000).

Shrub 1.5–3.5 m tall, recorded up to 1.5 m wide, single-stemmed at the base; young (actively growing) stems pale red-brown to dark reddish, 4-ridged at first; older stems with a smooth, shiny, grey, outer layer peeling off to reveal a darker, grey-brown layer. *Leaves* antrorse to widely spreading, almost straight to distinctly curved, mostly in fascicles. *Petioles* 0.8–1.7 mm long, poorly to moderately well defined. *Leaf blades* linear in outline, almost terete towards apex but adaxially somewhat flattened, 7–15 mm long, 0.3–0.5 mm diam., acute, relatively smooth. *Inflorescence* of 1–6 pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 4–13 mm long. *Bracteoles* 4–6 mm long, 2–3 mm wide, reddish with pale scarious margins 1.3–2.5 mm wide, with keel produced into a stout terminal horn; horn recurved distally, 1.2–3 mm long. *Pedicels* 1–3.5 mm long. *Buds* with 5 prominent, erect, pink or reddish horns and often deep pink petals. *Flowers* 10–13 mm diam. *Hypanthium* 2–4 mm long; adnate portion irregularly slightly rugose and with numerous oil glands, scarcely ribbed; free portion 0.4–0.8 mm long. *Outer sepals* 1–1.6 mm long, 1.3–1.9 mm wide, obtuse to irregularly truncate, prominently horned, the herbaceous portions reddish; scarious margin broad, petal-like, almost entire to distinctly toothed; horn very broad-based and sometimes with a downwards basal projection, distally incurved, 0.6–1.5 mm long. *Petals* 4–5 mm long, white or pale pink; margin minutely crenulate to distinctly denticulate. *Androecium* usually of 28–40 stamens, in fascicles of 5–10 opposite the sepals, sometimes also with solitary staminodes opposite some of the petals or at the margins of the fascicles; filaments connate for up to 0.6 mm, the longest 1.3–2 mm long; anthers 0.25–0.3 mm long; staminodes about as long as the longer stamens and with a very reduced, club-like, reddish anther, or without an anther and then sometimes very reduced. *Ovary* 3-locular; ovules 10–15 per loculus. *Style* 1.7–2.5 mm long, the basal 0.4–0.6 mm immersed; stigma 0.35–0.6 mm wide. *Fruits* 3-valvate, 2.5–3 mm long, 4–5 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds usually few, pale to medium brown. *Seeds* usually 8 or more per loculus, mostly with lateral surfaces somewhat flattened, 0.8–1.2 mm long, 0.5–0.7 mm thick; testa thin, cream or golden brown, smooth. (Figures 1D; 4D,E)

Diagnostic features. Single-stemmed *shrub*, growing in soil pockets on granite outcrops. *Flowers* 10–13 mm diam. *Outer sepals* prominently horned. *Petals* 4–5 mm long, white or pale pink. *Stamens* 28–40. *Staminodes* usually absent. *Ovary* 3-locular; ovules 10–15 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 10 Oct. 1994, *A.R. Annels* 4577, *T.D. Macfarlane* & *R.W. Hearn* (PERTH); 26 Nov. 1996, *E.D. Middleton* EDM 12 (PERTH); 8 Jan. 1997, *E.D. Middleton* EDM 20 A (PERTH); 25 Aug. 1997, *E.D. Middleton* EDM 46 (PERTH); 8 Oct. 1997, *E.D. Middleton* EDM 53 (PERTH); 4 Dec. 2002, *B.L. Rye* 221240 & *R.W. Hearn* (NSW, PERTH).

Distribution and habitat. Occurs on at least eight granite outcrops in an area with 1,000–1,300 mm annual rainfall, extending from near Weld River east to near Frankland River (Figure 9B). *Astartea granitica* is restricted to the middle-level and upper soil pockets of the outcrops where it is dominant and forms dense stands. Other taxa commonly associated with granite, such as *Verticordia plumosa*, occur nearby but tend to be excluded from the soil pockets where *A. granitica* is best established.

Phenology. Flowers mainly from early October to December.

Common name. Granite *Astartea*.

Conservation status. Priority Three under DEC Conservation Codes for Western Australian Flora; listed under *A. sp.* Mt Johnston (*A.R. Annels* 5645) in *Smith* (2012). This geographically restricted species lacks a lignotuber and is susceptible to dieback caused by *Phytophthora*.

Etymology. The epithet refers to the habitat of this species.

Affinities. This species and *A. middletonii* are unusual in having almost terete leaves and in their occurrence in soil pockets of granite outcrops. Both have large flowers with prominently horned sepals, but *A. middletonii* differs from *A. granitica* in having a lignotuber, with seedlings rarely produced, and a later flowering period. The two taxa apparently show a marked difference in seed and chaff colouring, although this needs confirmation, and they are geographically separated, with *A. middletonii* occurring closer to the coast and in a higher rainfall zone, south-west of the distribution of *A. granitica*. *Astartea middletonii* also tends to occur in deeper soil pockets where it grows in combination with *Taxandria*, whereas *A. granitica* is restricted to the higher, shallower pockets where it is more protected from fire and has no competition with *Taxandria*.

Co-occurring taxa. Having a specialised habitat on granite outcrops, this species rarely, if ever, occurs with other *Astartea* species.

Notes. *Astartea granitica* produces copious seedlings following fires or following the death of mature plants through drought or other factors. In soil pockets where adult plants have died, the seedlings are sometimes of two distinct sizes, with small, recently germinated seedlings as well as larger ones from the previous year. However, in soil pockets with a dense stand of mature plants, there are no seedlings. Seedlings have a pine-like growth form as on the two plants mounted on *E.D. Middleton* 20 A. For more detailed information on the biology of this species see *Hutchinson* (1997).

Astartea laricifolia Schauer in *W.G. Walpers, Repert. Bot. Syst.* 2: 922 (1843). *Leptospermum laricifolium* A.Cunn. ex Schauer *nom. inval.* in *W.G. Walpers, Repert. Bot. Syst.* 2: 922 (1843). *Type*: ‘In paludosis ad Sinum Regis Georgii III’ [in swamp near King George Sound, Western Australia], 31 January 1818, *A. Cunningham* 81 (*lecto*: BM 000758993, *fide* B.L. Rye, *Nuytsia* 16: 154 (2006); *?isolecto*: BM 000758994, 000758995, PERTH 07010834).

Astartea sp. wing tips (M.E. Trudgen 12044), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002).

Illustration. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002) [as *Astartea* sp. wing tips (M.E. Trudgen 12044)].

Shrub 1.5–5 m high, usually with a lignotuber in most situations but some plants or populations non-lignotuberous; young (actively growing) stems widely and delicately winged, golden brown to red-brown between the wings; wings expanded at the top of each internode to a recurved flange/protrusion 0.5–1.2 mm wide, pale grey and often brown- or red-tinged to golden brown; older stems with a pale grey, outer layer often with small black dots, eventually peeling off to reveal a brown underlayer. *Leaves* widely spreading, straight or somewhat curved, mostly in fascicles. *Petioles* 0.3–0.9 mm long, poorly or moderately well defined, rarely apparently absent. *Leaf blades* linear in outline, with adaxial surface flat or furrowed, 5–10.5 mm long, 0.35–0.5 mm wide, 0.35–0.5 mm thick, acute or obtuse, relatively smooth, dotted with numerous small oil glands. *Inflorescence* of usually 4–9 pairs of flowers per branchlet or with 2 or 3 pairs in each leaf fascicle spaced along each branchlet. *Peduncles* 1–2.5 mm long. *Bracteoles* usually caducous, 0.8–1.3 mm long, 0.2–0.25 mm wide, usually rather scarious; apex hooded, obtuse or acute. *Pedicels* 2.5–5.5 mm long, distinctly longer than the peduncle. *Buds* somewhat 5-lobed. *Flowers* 5.5–8 mm diam. *Hypanthium* 1.3–1.5 mm long, 2–2.5 mm wide; adnate portion irregularly slightly rugose and with oil glands becoming obvious in fruit, green; free portion 0.4–0.7 mm long, darker and smoother, usually reddish. *Outer sepals* 0.4–1 mm long, 0.8–1.1 mm wide, smooth or dorsally ridged; scarious margin almost entire. *Petals* 1.7–2.5 mm long, white; margin usually almost entire. *Androecium* of 30–41 stamens, in fascicles of 5–11 opposite the sepals and sometimes also 1 opposite 1–4 of the petals; filaments connate for up to 0.4 mm, the longest 0.9–1.3 mm long; anthers c. 0.2 mm long; staminodes few or absent, either on the margin of a fascicle or opposite a petal, usually long and unclubbed, up to 1.5 mm long. *Ovary* 3(4)-locular; ovules 13–16 per loculus. *Style* 1.5–1.8 mm long, the basal 0.3–0.4 mm immersed; stigma 0.2–0.25 mm wide. *Fruits* 3(4)-valvate, 1.5–2 mm long, 2–3 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds golden brown or darker brown. *Seeds* commonly 1–5 per loculus, 0.6–0.7 mm long, 0.4–0.5 mm thick; testa thin, creamy to golden brown, smooth. (Figure 1E)

Diagnostic features. Tall *shrub* or small *tree* occurring in very damp habitats with tall vegetation; young stems prominently winged. *Flowers* 5.5–8 mm diam. *Sepals* smooth or ridged. *Petals* 1.7–2.5 mm long, white. *Stamens* 30–41. *Staminodes* usually absent. *Ovary* 3-locular; ovules 13–16 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERN AUSTRALIA: 18.5 km E of Walpole, track off Peaceful Bay Rd, Walpole–Nornalup National Park, 19 Jan. 1989, *A.R. Annels* 664 (PERTH); King George Sound, 1828–1829, *W. Baxter s.n.* (BM 000603454); 2.2 km S of NE corner of Yelverton Forest Block, 3 Dec. 1996, *N. Casson & T. Annels* SC 29.20 (PERTH); Brockman Highway 9 km E of Sues Rd intersection, 10 Jan. 2001, *R.J. Cranfield* 16206 (PERTH); on Meerup River, 50 m N of old track, 27 Feb. 1997, *C. Day & P. Ellery* P 74.1A (PERTH); no precise locality, *J. Drummond* [coll. 2?] n. 3 (MEL 76294); Marrinup Brook, Marrinup, 26 Feb. 1921, *C.A. Gardner* 706 (PERTH); Chester Pass, Stirling Range, 16 Jan. 1936, *C.A. Gardner s.n.* (PERTH); King George Sound, Jan. 1834, *C.A. von Huegel s.n.* (W); Bow River, Dec. 1912, *S.W. Jackson s.n.* (NSW, PERTH); 1.3 km W of Angrove Rd/Centre Rd intersection, 13 Feb. 1997, *C. McChesney & C. Day* W 35.1 (PERTH); Break Rd, 3.8 km W of Harewood Rd and 6.2 km E of Fernley Rd, 22 Jan. 2003, *B.L. Rye* 230145, *R.W. Hearn & B.G. Hammersley* (PERTH); Broke Inlet Rd, 4.6 km E of Chesapeake Rd, 23 Jan. 2003, *B.L. Rye*

230175 & R. W. Hearn (AD, BRI, PERTH); Sandalwood Rd, 3.6 km NW of turnoff into camping area and 6.4 km SE of Mettler Lake Rd in Reserve 31240, NW of Cape Riche, 7 Jan. 2010, B.L. Rye 290132 (PERTH); W across inlet from Walpole township, 13 Feb. 1994, M.E. Trudgen 12044 (PERTH); King George Sound, 1880, Webb 45 (MEL).

Distribution and habitat. Distributed mainly from Augusta east to near Cape Riche, also extending north to Dwellingup (Figure 10A), and possibly also occurring further east. Occurs in very damp habitats with tall vegetation, especially in deep gullies along small watercourses.

Phenology. Flowering is recorded from early December to early March, especially from mid-December to early February.

Conservation status. Not currently considered to be at risk, as it has many large populations and is known from a number of national parks and other reserves.

Etymology. From the Latin *larix* (larch tree) and *folium* (leaf), as this species has leaves that are slender and densely clustered like those of the larch.

Common name. Winged Astartea.

Affinities. This species is a very distinctive member of the *A. scoparia* group, differing from other members of that group in having the pedicels always distinctly longer than the peduncles. Internodes of rapidly growing shoots are 4-winged, usually very prominently so, and the leaves are always in fascicles. The prominently winged stems distinguish *A. laricifolia* from all other members of the genus, although some relatively dormant specimens have much less obvious wings.

Astartea laricifolia is also notable in having an exceptionally strong odour of aromatic oils when its leaves are crushed. These chemicals are likely to include myrtenal and myrtenol, both of which discourage insects and so might give the species some protection against foragers (see Lowe *et al.* 2005).

Co-occurring taxa. Although *A. laricifolia* has been recorded growing with many other *Astartea* species, its tendency to occupy a distinct habitat, always with tall, dense vegetation, means that it frequently occurs alone. Another species found in tall vegetation is *A. leptophylla*, but it occurs on river banks that are subject to destructive flooding whereas *A. laricifolia* occurs in more stable habitats. Both *A. laricifolia* (M. Koch 2125) and *A. leptophylla* (type specimen) have been recorded from Preston River. A collection from Meerup River (C. Day & P. Ellery P 74.1) has one piece (A) definitely of *A. laricifolia* with prominently winged stems and two others (B) similar to *A. leptophylla* in their stems but still with short peduncles like *A. laricifolia*; the latter two might possibly be from a hybrid.

Notes. Very prominently winged stems similar to those of *A. laricifolia* occur in the closely related genus *Hypocalymma*, in *H. cordifolium*. *Hypocalymma cordifolium* has a similar distribution, being concentrated along the south coast in damp habitats. Presumably these environmental similarities have led to the stem morphology convergence between the two species, although they differ considerably in most other characters.

The only known specimen of *A. laricifolia* from the Stirling Range (C.A. Gardner s.n., 16 Jan. 1936) has c. 40 stamens per flower including one opposite most of the petals. No other specimens have been found so far with as many stamens opposite the petals, but some flowers with one or two antipetalous stamens are present on a range of specimens.

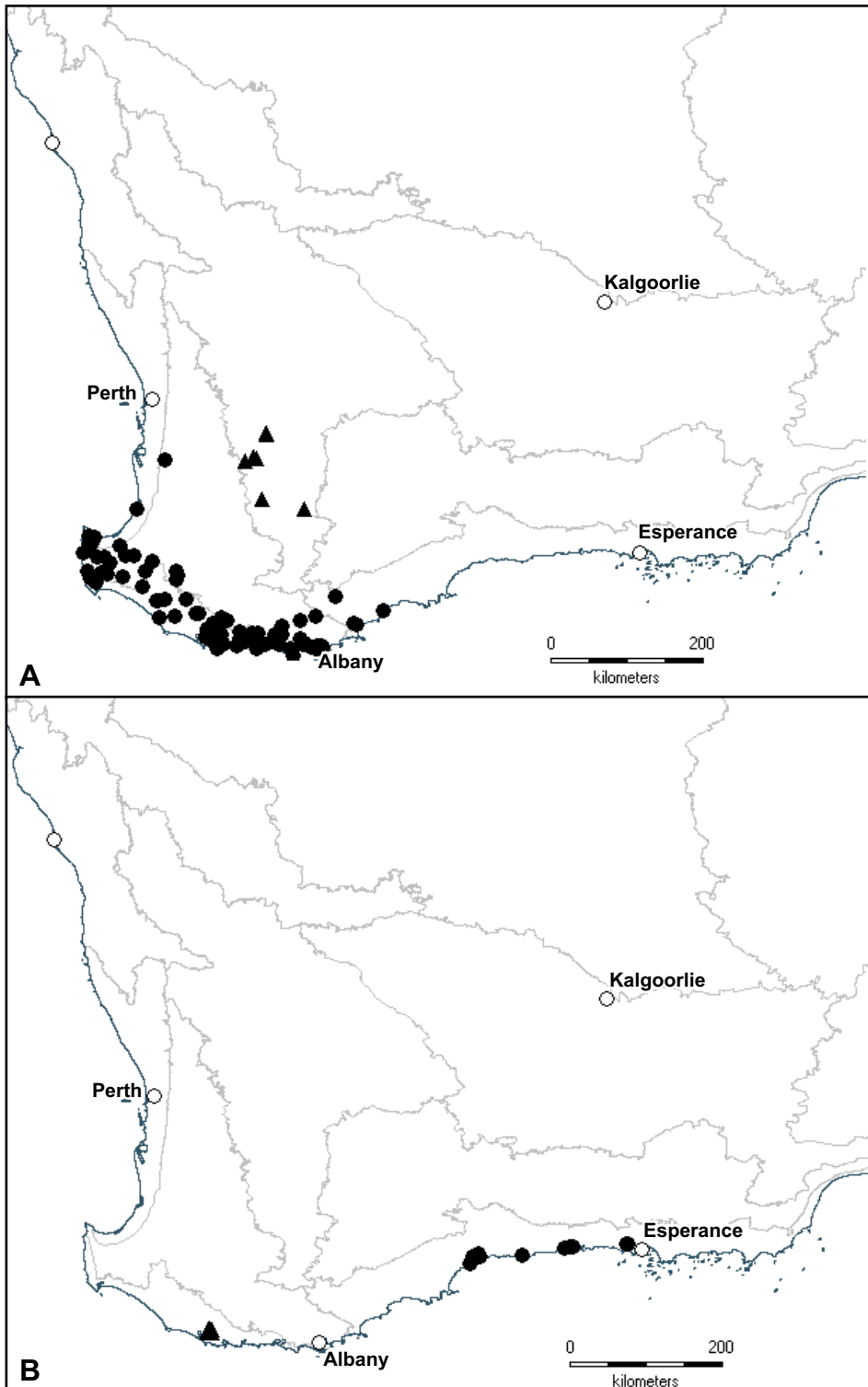


Figure 10. Distributions of *Astartea* species. A – *A. laricifolia* (●), *A. muricata* (▲); B – *A. middletonii* (▲), *A. reticulata* (●).

Astartea leptophylla Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 113 (1844). *Type*: ‘In umbrosis ad ripam fluvii Preston (prov. Wellington), solo limoso’ [shady river bank, muddy site, Preston River, Western Australia], 1 January 1840, *L. Preiss* (Herb. Preiss No.) 156 (*holo*: LD; *iso*: MEL 2147398).

Astartea sp. rivers (K.R. Newbey 1740), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002).

Illustration. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002) [as *Astartea* sp. rivers (K.R. Newbey 1740)].

Shrub 2–5 m high, without a lignotuber but frequently reproducing by layering, with trunk commonly blackened and often with debris or lichens; young (actively growing) stems 4-ridged or very narrowly 4-winged at first; older stems with a smooth, grey, outer layer eventually peeling off to reveal a darker, grey-brown layer. *Leaves* antrorse to widely spreading, mostly in fascicles, straight or somewhat curved. *Petioles* 0.5–2 mm long, poorly differentiated and often appearing to be absent. *Leaf blades* linear in outline, with adaxial surface flat or furrowed, 8–16 mm long, 0.5–0.8 mm wide, 0.4–0.5 mm thick, acute or obtuse, relatively smooth. *Inflorescence* of usually several pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 2–4.5 mm long. *Bracteoles* 1–1.7 mm long, 0.25–0.35 mm wide; apex hooded, obtuse, sometimes with a slight dorsal point. *Pedicels* 2–4 mm long. *Buds* somewhat 5-lobed. *Flowers* 6.5–9 mm diam. *Hypanthium* 1.6–2 mm long, 2.5–3 mm wide; adnate portion irregularly slightly rugose and with numerous oil glands; free portion 0.5–0.8 mm long. *Outer sepals* 0.6–1 mm long, 0.9–1.3 mm wide, smooth or slightly ridged dorsally; scarious margin almost entire. *Petals* 2.3–3 mm long, white; margin almost entire to denticulate. *Androecium* usually of 28–40 stamens, in fascicles of 4–10 opposite the sepals; filaments connate for up to 0.4 mm, the longest 1–1.3 mm long; anthers 0.2–0.25 mm long; staminodes few or absent, usually long and unclubbed. *Ovary* 3-locular; ovules 9–13 per loculus. *Style* 1–1.5 mm long, the basal 0.4–0.5 mm immersed; stigma 0.25–0.3 mm wide. *Fruits* 3-valvate, 1.5–1.7 mm long, 2.3–2.5 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds medium brown or reddish brown. *Seeds* usually several per loculus, 0.7–1.1 mm long, 0.35–0.6 mm thick; testa thin, cream or golden brown, smooth.

Diagnostic features. Tall *shrub* or small *tree*, single-stemmed or layering, occurring on river banks. *Flowers* 6.5–9 mm diam. *Sepals* smooth or slightly ridged. *Petals* 2.3–3 mm long, white. *Stamens* 28–40. *Staminodes* usually absent. *Ovary* 3-locular; ovules 9–13 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERN AUSTRALIA: Blackwood River, *J. Forrest s.n.* (MEL 76235); banks of Canning River, Roleystone, 23 Dec. 1967, *G. Heinsohn* 158 (PERTH); St Johns Brook, N of Barrabup Pool, NW of Nannup, 26 Dec. 2000, *M. Hislop* 2178 (PERTH); Hay River, 2 Dec. 1994, *G. Janicke* 268 (PERTH); Alexandra Bridge, where Brockman Hwy crosses Blackwood River, 6 Jan. 1985, *R.A. Kilgour* 523 (MEL, PERTH ex MEL); Wheatley’s Mill, 25 Jan. 1918, *G.E. Lane-Poole s.n.* (PERTH); Blackwood River c. 2 miles [3 km] W of junction with Rosa Brook, E of Karridale, 3 Jan. 1971, *B.R. Maslin* 1611 (NSW, PERTH); N bank of river, Margaret River, off Carters Rd, 12 Jan. 2005, *A. Matei* R 205 (PERTH); Warren River, Manjimup, 21 Mar. 1996, *J. Moore s.n.* (PERTH); valleys of the Serpentine River, Darling Range, 1 Dec. 1877, *F. Mueller s.n.* (MEL 75938); Tone River, c. 0.1 km E of Tone River Bridge on Mordalup Rd, 21 Jan. 2003, *B.L. Rye* 230105 & *R.W. Hearn* (PERTH); Fernhook Falls at Beardmore Rd crossing of Deep River, 23 Jan. 2003, *B.L. Rye* 230162 & *R.W. Hearn* (AD, BRI, PERTH); Fernley Rd at bridge over Styx River, 22 Jan. 2003, *B.L. Rye* 230146 & *R.W. Hearn* (PERTH); creekline below Mundaring Weir, where main road

crosses it, 22 Mar. 1992, *M.E. Trudgen* 10755 (PERTH); Lease Rd, Donnelly River crossing, 8 Dec. 1999, *V.L. Tunsell, R.J. Cranfield & R.W. Hearn* 076 (PERTH).

Distribution and habitat. Occurs on the banks of rivers in near-coastal areas of the south-west, extending from Helena River near Perth to Hay River (Figure 8B). Apparently restricted to watercourses that are fast-flowing in winter, mostly occurring on unstable muddy banks. At Fernhook Falls in the Deep River, the species occurs on granite islands in the river as well as on the banks.

Phenology. Flowers mainly mid-December to early February.

Conservation status. Not currently considered to be at risk, as it has numerous populations spread over a large range.

Etymology. From the Greek *leptos* (thin) and *phyllus* (leaf), as this species has particularly narrow leaves.

Common name. River-bank *Astartea*.

Affinities. *Astartea leptophylla* can be confused with *A. scoparia* but differs in its habit, its usually longer, finer leaves and its higher ovule numbers. It occupies a different, more specific habitat, always occurring along the banks of major watercourses whereas *A. scoparia* is associated with swamps and minor watercourses.

Co-occurring taxa. The unusual habitat of this species generally isolates it from other *Astartea* species. See the note under *A. laricifolia* regarding the possible occurrence of that species with *A. leptophylla*. Another species *A. leptophylla* might occasionally grow near is *A. scoparia*. Although no instances of co-occurrence of the two species have been documented, a few herbarium specimens that appear to have somewhat intermediate leaves are difficult to place with certainty.

Notes. *Astartea leptophylla* seems to be the tallest species of *Astartea*, rivalled only by *A. laricifolia*. Both taxa are restricted to particularly damp habitats with tall vegetation.

Astartea middletonii Rye, *sp. nov.*

Typus: D'Entrecasteaux National Park, Western Australia [precise locality withheld for conservation reasons], 12 November 1997, *E.D. Middleton* 78 (*holo:* PERTH 04575806; *iso:* CANB, MEL).

Astartea sp. Pingerup rock (E.D. Middleton 78), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Shrub 1–2.5 m tall, producing multiple stems from a lignotuber; young (actively growing) stems 4-ridged at first; older stems with a smooth, shiny, grey outer layer peeling off to reveal a darker grey-brown layer. *Leaves* antrorse to widely spreading, tending to be directed upwards on horizontal stems (i.e. all appearing to be on top of stem), mostly in fascicles, almost straight to distinctly curved. *Petioles* 0.8–1.5 mm long, usually poorly defined. *Leaf blades* linear in outline, almost terete towards apex but somewhat flattened on adaxial surface or with an adaxial groove towards the base, 10–15 mm long, 0.5–0.6 mm diam., acute or mucronulate. *Inflorescence* usually of several to many pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 4–8 mm long. *Bracteoles* 3.5–5.5 mm

long, 2.1–3 mm wide, reddish with pale scarious margins 1.5–2 mm wide, with keel produced into stout terminal horn; horn recurved distally, 1.3–1.9 mm long. *Pedicels* 1.5–3.5 mm long. *Buds* with 5 prominent, erect, pink or reddish horns and often deep pink petals. *Flowers* 11–15 mm diam. *Hypanthium* 2–3 mm long, 3–5 mm diam.; adnate portion irregularly rugose and with numerous oil glands, scarcely ribbed; free portion 0.6–1 mm long. *Outer sepals* 1–1.6 mm long, 1.9–2.2 mm wide, prominently horned, the herbaceous portions reddish; scarious margin broad, petal-like, almost entire to distinctly denticulate; horn broad-based, distally incurved, 0.6–1.4 mm long. *Petals* 4–6 mm long, white or pale pink; margin minutely crenulate to distinctly denticulate. *Androecium* of 37–60 stamens, in fascicles of 6–13 opposite the sepals, sometimes also with solitary (very rarely 2) stamens opposite some of the petals, sometimes also with a few staminodes; filaments connate for up to 0.6 mm, the longest 1.7–2.1 mm long; anthers 0.25–0.3 mm long; staminodes (when present) usually about as long as the longest stamens and with a small terminal club. *Ovary* 3-locular; ovules 13–15 per loculus. *Style* 1.6–2.3 mm long, the basal *c.* 0.7 mm immersed; stigma *c.* 0.3 mm wide. *Fruits* 3-valvate, 1.8–2 mm long, 3.3–4 mm diam.; hypanthium shallowly hemispheric; abortive ovules/seeds deep red. *Seeds* not seen fully mature, several or more per loculus, mostly with lateral surfaces somewhat flattened, 0.7–0.8 mm long, 0.4–0.5 mm thick; testa thin, white with a red patch on the inner margin above the inner protrusion, smooth.

Diagnostic features. Lignotuberous *shrub* growing in soil pockets on granite outcrops. *Flowers* 11–15 mm diam. *Outer sepals* prominently horned. *Petals* 4–6 mm long, white or pale pink. *Stamens* 37–60. *Staminodes* few or absent. *Ovary* 3-locular; ovules 13–15 per loculus. *Seeds* with a thin testa, partially red, smooth.

Selected specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 16 Dec. 1999, *E.D. Middleton* TEDW 115 (PERTH); 18 Dec. 1999, *E.D. Middleton* TEDW 124 (PERTH); 18 Dec. 1999, *E.D. Middleton* TEDW 126 (PERTH); 18 Dec. 1999, *E.D. Middleton* TEDW 127 (PERTH); 4 Dec. 2002, *B.L. Rye* 221235 & *R.W. Hearn* (PERTH); 23 Jan. 2003, *B.L. Rye* 230163 & *R.W. Hearn* (AD, NSW, PERTH); 3 Dec. 1997, *S. Watkin* 387 (PERTH), 388 (PERTH).

Distribution and habitat. Restricted to a few granite outcrops in a small area north of Broke Inlet with an annual rainfall of *c.* 1,400 mm (Figure 10B). Occurs in soil pockets on large outcrops in nutrient-rich, sandy soil over granite. It often grows intermixed with *Taxandria linearifolia* in the deeper soil pockets. Other species occurring in the same or shallower pockets include *Acacia myrtifolia*, *Verticordia plumosa* and *Pimelea imbricata*. In addition to these natural populations, a few specimens (e.g. *E.D. Middleton* TEDW 124) have been collected from disturbed roadside locations in more sandy localities below the granite rocks, possibly transferred there by vehicles.

Phenology. Flowers recorded from mid-November to January.

Conservation status. Priority Two under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Pingerup rock (*E.D. Middleton* 78) in Smith (2012). This species has a lignotuber and rarely produces seedlings. It is very restricted in distribution, its total range extending for less than 10 km on scattered granite outcrops that mostly have large populations surrounded by dense, tall, forest undergrowth, making access to them difficult.

Etymology. This species is named after its discoverer, Ted Middleton, who has surveyed and collected it from throughout its known range.

Affinities. Somewhat intermediate in morphology between *A. granitica* and *A. schaueri*, resembling the former more closely in its habitat, height, stamen numbers and ovule numbers, but resembling the latter more in having a lignotuber and in its apparently more reddish seeds. See the notes under those two species. All three species are similar in having large bracteoles and prominently horned sepals.

Co-occurring taxa. Having a specialised habitat on granite outcrops, this species rarely occurs with other *Astartea* species.

Notes. *Astartea middletonii* has the largest flowers in the genus and tends to produce the most numerous stamens. As with other species, however, the flower size is very variable and can be reduced to less than 11 mm diam. in very water-stressed plants. The length of the sepal horn is also very variable, with long-horned and short-horned plants recorded from the same populations. One specimen with very numerous stamens (*E.D. Middleton* TEDW 116) occasionally has two stamens, sometimes one long and one short, opposite one of the petals.

This species apparently has poor seed set in comparison with other *Astartea* species, mainly through the abortion of whole fruits, with the plants drying off rapidly after flowering and a majority of the flowers failing to develop into fruits. Where fruits are successfully formed, however, the proportion of ovules producing seeds appears to be reasonably high. In January 2003, attempts to collect fully developed fruits from one of the populations were barely successful, although this may have been due in part to it having been a particularly dry year. Ted Middleton (pers. comm.) has never seen seedlings of this species and has been unable to grow it from seed, in contrast with *A. granitica*, which produces copious seeds and seedlings. However, the occasional occurrence of specimens along disturbed roadsides suggests that *A. middletonii* is successfully reproducing by seed even if not as prolifically as the other species. The few immature seeds examined resembled the immature seeds of *A. schaueri* in colouration and would appear therefore likely to become more red-spotted at maturity as in that species.

Astartea montana* Rye, *sp. nov.

Typus: Stirling Range Drive, 13.7 km west of Chester Pass Road, Western Australia, 6 December 2002, *B.L. Rye* 221263 (*holo:* PERTH 06585787; *iso:* CANB, K, MEL).

Astartea sp. staminodes (*A. Strid* 21584), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Shrub 0.5–1 m high, producing multiple stems from a lignotuber; young (actively growing) stems red-brown, with narrow ridges or wings up to 0.2 mm wide; older stems deep red-brown then becoming pale grey, sometimes developing opposite-decussate stripes of pale grey epidermis (each stripe extending from the base of a leaf down to the next node) alternating with reddish brown stripes but tending to be more uniform. *Leaves* mostly in fascicles, slightly curved to straight. *Petioles* 0.7–1.2 mm long, poorly defined. *Leaf blades* narrowly or very narrowly obovate from side view, 4–7.5 mm long, 0.4–1 mm wide, 0.5–0.8 mm thick, obtuse. *Inflorescence* of several to many pairs of flowers spread along the branchlets. *Peduncles* 2.5–4 mm long. *Bracteoles* 1.8–3.5 mm long, 0.35–0.6 mm wide, sometimes dark reddish, the hooded apex sometimes with a small dorsal point up to 0.2 mm long; scarious margins entire. *Pedicels* 1.3–2.5 mm long. *Buds* with apex fairly flat to somewhat 5-lobed. *Flowers* (6–)7–10 mm diam. *Hypanthium* 1.3–2 mm long, 2–2.6 mm wide; adnate portion prominently reticulate-pitted; free portion 0.4–0.6 mm long. *Outer sepals* 0.9–1.2 mm long, 1.5–1.8 mm wide, dorsally

smooth to very ridged; scarious margin entire. *Petals* 2.5–4 mm long, almost white to medium pink, usually pale pink; margin entire or almost so. *Androecium* of 21–35 stamens and up to 10 staminodes, with 3–8 stamens per fascicle and often also 1 stamen opposite 1–5 petals, the fascicles and solitary stamens often united into a continuous arc or circle of filaments; filaments connate for up to 0.5 mm, the longest 1.1–1.5 mm long; anthers *c.* 0.25 mm long; staminodes commonly 2 per fascicle with one on each margin of fascicle, sometimes reduced to 1 or absent from some fascicles (rarely replaced by a long stamen with a very slender filament but normal-sized anther), rarely also 1 opposite a petal, either attenuate or with a very reduced sterile anther forming a small club, distinctly longer than the stamens, up to 2.6 mm long, often twisted. *Ovary* 3-locular; ovules 8–12 per loculus. *Style* 1.6–2.1 mm long, the basal 0.4–0.7 mm immersed; stigma up to *c.* 0.3 mm wide. *Fruits* 3-valvate, *c.* 2 mm long, *c.* 3 mm diam.; hypanthium somewhat 3-lobed; abortive ovules/seeds dark red-brown. *Seeds* up to 5 per loculus, 0.75–1.1 mm long, 0.4–0.6 mm thick; testa thin, with red markings, smooth. (Figure 3D–F)

Diagnostic features. Lignotuberous *shrub* occurring in rocky sites. *Flowers* 6–10 mm diam.; hypanthium reticulate-pitted. *Outer sepals* smooth to very ridged. *Petals* 2.5–4 mm long, almost white to medium pink. *Stamens* 21–35. *Staminodes* up to 10. *Ovary* 3-locular; ovules 8–12 per loculus. *Seeds* with a thin testa, mottled, smooth.

Selected specimens examined. WESTERN AUSTRALIA: 15 miles [24 km] from Chester Pass Rd along Stirling Range Drive towards Red Gum Pass, 23 Oct. 1968, *E.M. Canning* 68/6650 (PERTH); Bluff Knoll, massif, 23 Dec. 1979, *H.E.M. Dobson* 79014 (PERTH); 1848–1849, *J. Drummond* coll. 5, n. 125 (K, NSW, PERTH); lookout S of Mt Gog, Stirling Range Drive, 24 km from Chester Pass Rd, 23 Oct. 1991, *W. Greuter* 23160 (PERTH); walk trail along E shoulder of Mt Trio, 29 Dec. 2001, *M. Hislop* 2523 (PERTH); 7 km N along Chester Pass Rd from junction of Stirling Range Drive, 25 Oct. 1985, *N. Hoyle* 1254 (PERTH); base of Toll Peak, 22 Nov. 1979, *G.J. Keighery* 2595 (PERTH); ascent on NW slope of Bluff Knoll, 12 Dec. 1982, *K.H. Rechinger* 60413 (PERTH); Bluff Knoll Peak, 14 Feb. 1988, *A. Rose* 1007 (PERTH); Bluff Knoll walk track, at saddle between Bluff Knoll and Coyanarup Peak, 30 Dec. 1991, *A. Rose* 1111 (PERTH); lookout S of Mt Gog on Stirling Range Drive, 24 km W of Chester Pass Rd and 17 km E of Red Gum Pass, 6 Dec. 2002, *B.L. Rye* 221264 (PERTH); Mondurup Peak, steep ravine on northern side, 24 Nov. 1982, *A. Strid* 21551 (PERTH); by Stirling Range Drive, N of Toolbrunup Peak, 25 Nov. 1982, *A. Strid* 21584 (PERTH); near Bluff Knoll car park, 20 Mar. 1976, *M.E. & M.E. Trudgen* 1643 (AD, BRI, PERTH); Mt Trio eastern peak, W from road, 29 Dec. 1988, *R.T. Wills* 926 (PERTH).

Distribution and habitat. Occurs mainly in Stirling Range National Park, recorded from a number of peaks extending from Mondurup Peak east to Bluff Knoll, and from swampy areas between the peaks (Figure 9B). It occurs in rocky soil, variously recorded as having laterite, quartzite or sandstone. An isolated population in the Manypeaks area needs further study.

Phenology. Flowers recorded mainly from late October to early January, but also recorded until late March. Mature fruits and seeds seen on only two specimens (*A. Rose* 1007 & *M.E. & M.E. Trudgen* 1643).

Common name. Stirling Range Astartea.

Conservation status. Not currently considered to be at risk. Although it has a fairly restricted distribution, nearly all its known populations are protected within a large national park.

Etymology. From the Latin *montanus* (pertaining to mountains), this species being largely restricted to the Stirling Range, which includes the highest peaks of south-western Australia. *Astartea montana* occurs mainly, but not entirely, at higher altitudes than all other members of the genus.

Affinities. This species has been confused with *A. fascicularis* because both species have large flowers with staminodes commonly produced on each side of the stamen fascicles, but the two taxa do not appear to be particularly closely related, and they show significant differences in their ovule numbers and seed colouration. The white inner protrusion on the seed is very prominent in *A. montana* and strongly contrasts with the red-mottled testa of the seed body.

Astartea montana is most similar to species that have a reticulate-pitted hypanthium, such as *A. glomerulosa*. Some specimens of this group that are lignotuberous like *A. montana* have been given the informal name *A. sp.* southern ranges (T.E.H. Aplin 2108); these lack staminodes and occur predominantly in lower altitudes south of the Stirling Range. Further studies are needed to determine the status of this unnamed taxon.

Co-occurring taxa. This species has not been recorded growing with any other *Astartea* species.

Notes. The appearance of the androecium is quite variable in *A. montana*. The stamens are sometimes arranged, as in *M. Hislop* 2523, in a complete ring (rather than discrete antisepalous fascicles or free stamens), although still united higher opposite the sepals. The specimen with the largest number of stamens, *M.E. & M.E. Trudgen* 1643, has a solitary stamen opposite each petal and usually only one staminode at the margin of each sepal. Two other extremes are specimens either with very few staminodes or with 10 staminodes and relatively few stamens. The staminodes are very obvious as they are up to twice as long as the stamens.

Astartea muricata Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersburg* 10: 334 (1852). *Type*: ?Brogden [probably from the route to Albany via the Williams area, Western Australia], 1843–1844, *J. Drummond* coll. 3, n. 35 [as coll. 5, n. 25 *ex parte*] (*holo*: KW *n.v.*, photograph PERTH 07523408; *iso*: PERTH 03852520 ex BM, 06172652 ex K).

Shrub 0.4–1 m tall, recorded up to 0.7 m wide, single-stemmed at base but often branching close to base, with a tap root and several horizontal main roots radiating just below the soil surface; young (actively growing) stems 4-ridged, not or scarcely winged, with numerous crown-shaped outgrowths; older stems pale grey. *Leaves* mostly in fascicles, slightly curved to straight. *Petioles* 0–0.5 mm long, absent or poorly defined. *Leaf blades* narrowly or very narrowly obovate from side view, 3–8 mm long, 0.5–0.8 mm wide, 0.5–0.9 mm thick, obtuse, often with crown-shaped outgrowths. *Inflorescence* mostly with 1 to several pairs or clusters of flowers on each lateral branchlet along each main branchlet. *Peduncles* 2–5 mm long, 1–3-flowered (usually 1-flowered), occasionally with 2 peduncles in a single axil, much longer than the pedicel; secondary peduncles present only on the younger lateral flowers of 2- or 3-flowered peduncles, commonly 0.5–0.8 mm long. *Bracteoles* 0.6–1 mm long, 0.3–0.4 mm wide, the apex hooded; scarious margins narrow, entire; point ± absent. *Pedicels* 0.5–1.5 mm long. *Flowers* 5.5–8 mm diam. *Hypanthium* 1.3–1.8 mm long, 1.6–2.5 mm diam., with slight to prominent ribs opposite the sepals and sometimes also opposite the petals; adnate portion somewhat rugose and gland-dotted; free portion 0.3–0.5 mm long. *Outer sepals* depressed-semicircular, 0.4–0.6 mm long, 0.9–1.5 mm wide, reddish; scarious margin narrow, clear-translucent, entire, fairly smooth or somewhat ridged dorsally. *Petals* pale pink or white, very broadly obovate, 2.2–3 mm long; margin entire. *Androecium* of 22–35 stamens, in fascicles of 3–10 stamens (always with 6 or more stamens

present in some of the fascicles) opposite the sepals, rarely also with a solitary stamen or a fascicle opposite one of the petals in partially 6-merous flowers; filaments connate for up to 0.5 mm, the longest 0.8–1.4 mm long; anthers *c.* 0.25 mm long; staminodes absent or rare. *Ovary* 3(4)-locular; ovules 10–16 per loculus. *Style* 1–1.6 mm long, the basal 0.4–0.5 mm immersed; stigma 0.25–0.35 mm wide. *Fruits* 1.4–1.6 mm long, 2.3–3.7 mm diam.; hypanthium hemispheric; undeveloped ovules/seeds dark red-brown. *Seeds* probably several to over 10 per loculus, often somewhat compressed bilaterally, 0.6–0.8 mm long, 0.35–0.5 mm thick; testa relatively thick, colliculate or reticulate-pitted, dark red-brown. (Figure 2A)

Diagnostic features. Single-stemmed or basally branched *shrub* associated with watercourses and winter-wet depressions; young stems muricate. *Flowers* 5.5–8 mm diam. *Sepals* smooth or somewhat ridged. *Petals* 2.2–3 mm long, pale pink or white. *Stamens* 22–35. *Staminodes* usually absent. *Ovary* 3-locular; ovules 10–16 per loculus. *Seeds* with a thick testa, dark red-brown, colliculate or reticulate-pitted.

Selected specimens examined. WESTERN AUSTRALIA: N boundary of Wishbone Reserve, Dumbleyung Shire, 3 Oct. 1995, *E.M. Bennett & C. Day* WB opp 60 (PERTH); 10.5 km S of Hotham River, private property adjacent to Great Southern Hwy, 28 Oct. 1995, *D. Box* 10 (PERTH); 1 km W of Aldersyde, 21 Oct. 1983, *R.J. Cranfield* 4506 (PERTH); ‘Swan River, 1848’ [possibly coll. 4: 52, collected in 1846–1847], *J. Drummond* 52 (PERTH); *J. Drummond s.n.* (MEL 73189, 76201, 76440, 76295); near Hotham River, Popanyinning, 5 Dec. 1922, *C.A. Gardner* 1876 *p.p.* (PERTH); Arthur River crossing 100 m W of the turnoff into Piesseville Rd from Piesseville–Tarwonga–Ballagin road, NW of Wagin, 21 Jan. 2005, *F. & J. Hort* 2497 (AD, MEL, NSW, PERTH); Brookton–Queda [Kweda] road, 1.2 km W of Aldersyde Rd, 6 Dec. 2002, *B.L. Rye* 221266 (CANB, DNA, PERTH).

Distribution and habitat. Known from an inland area bounded by Aldersyde, the Hotham River and Wishbone Reserve, near Dumbleyung (Figure 10A). Recorded from the banks of rivers and other damp habitats.

Phenology. Flowers recorded late September to early December. Fruits recorded late October to December.

Common name. Inland Astartea.

Chromosome number. Rye (1979) recorded the chromosome number of $2n = 44$ [as *A. clavulata*]. The voucher specimen, *B.L. Rye* 76035, was cultivated at Kings Park and is of unknown origin. Its identification is not certain although it is clearly a member of the *A. aspera* group. It has seeds with a uniformly dark red, shallowly pitted testa, peduncles longer than the pedicels, and large stamen and ovule numbers suggestive of *A. muricata*.

Conservation status. Not currently considered to be at risk; it has a known range *c.* 120 km long and one population is in a nature reserve. A more vulnerable population near Aldersyde has many plants at varied stages of development scattered along a roadside drain for *c.* 200 m. It is not known how many populations occur along the Hotham River.

Etymology. From the Latin *murex* (a shellfish with a rough-textured shell), referring to the texture of the young stems, which are always densely covered by star-like protrusions.

Type information. The type of *A. muricata* is cited by Bailey (1991) as being number 25 from Drummond’s

supplement to his Fifth Collection (5S: 25), as Turzcaninow (1852) cited it as ‘Drum. V, n. 25, ex parte’. In the same publication, Turzcaninow published the names *Harmogia parviflora* Turcz. based on ‘Drum. V, n. 25’ and *Harmogia leptophylla* Turcz. based on ‘Drum. V, n. 35, ex parte’. It appears that the correct number for the type of *A. muricata* is number 35 from Drummond’s Third Collection, as material of 3: 35 matches the protologue very well but no material of *Astartea* has found under 5S: 25. Turzcaninow certainly had access to material of Drummond’s Third Collection including number 35, so it seems probable there was no admixture in 5S: 25, but rather all material was of *H. parviflora*, while 3: 35 had mixed material of *Astartea* and *H. leptophylla*. Indeed, there appear to have been several consecutive numbers duplicated in the Third Collection, including 3: 38, which contained the type material of both *Harmogia serpyllifolia* Turcz. and *Scholtzia drummondii* Benth.

Drummond would have passed through the region of occurrence of *A. muricata* in mid- to late November 1843, a good time of year to have found the species in flower, while travelling south to King George Sound; he would also have returned through that region before reaching his home near Toodyay in early 1844 (see Erickson 1969).

There are also four sheets of *A. muricata* at MEL (73189, 76440, 76201, 76295) labelled as *Baeckea* and collected by James Drummond but with no date and no precise locality. All have slender leaves, multiple peduncles in a few of the axils (the peduncles up to 5 mm long) and MEL 76201 has large flowers with filaments up to 1.4 mm long. These do not appear to be part of the type collection.

Affinities. This species is similar to *A. aspera* in its muricate stems. It tends to have more stamens and ovules than *A. aspera* but there is considerable overlap in these characters. However, in populations of *A. aspera* that do have high stamen numbers, there are also very low numbers present, with numbers ranging from one to ten opposite each sepal having been recorded on the same plant. There may also be a difference in seed characters, but good samples of mature seeds are needed to check this possibility.

Over half of the specimens of *A. muricata* have more than one flower in some of their axils, including the type material, which has several 2-flowered peduncles and one 2-pedunculate axil. One specimen with many multi-flowered axils is R.J. Cranfield 4506; 2- or 3-flowered peduncles are fairly common on this specimen and there are also a few axils with two superposed peduncles. In 2-pedunculate axils the outer (abaxial) peduncle is shorter and later to mature (i.e. when the inner peduncle has an open flower, it still has a bud) and the lateral flowers of the main peduncle open later than the central flower. In *A. aspera* the pedicels are as long as or longer than in *A. muricata* but the peduncles are often shorter than in *A. muricata* and are always 1-flowered.

Co-occurring taxa. There is no known overlap between the entirely inland distribution of this species with those of all other *Astartea* species. However, the population of *A. scoparia* that occurs the furthest inland is almost on the margin of *A. muricata*’s range.

Notes. An *Astartea* species recorded from Lake Coyrecup, near Katanning, as *A. fascicularis* by Lyons (1988) is likely to be a member of the *A. aspera* group, as it occurs in the gap between the known ranges of *A. aspera* and *A. muricata*. It could, however, belong to a different genus such as *Cyathostemon*. Unfortunately there is no voucher specimen lodged at PERTH.

Good fruiting material with mature seeds is still needed for *A. muricata*. In the most mature fruits examined the chaff pieces appear to be colliculate and the immature seeds very shallowly pitted, with the inner protrusion whitish.

Astartea onycis Rye & Trudgen, *sp. nov.*

Typus: Scott National Park, Western Australia [precise locality withheld for conservation reasons], 17 November 1982, *A. Strid* 21792 (*holo*: PERTH 01898116; *iso*: CANB, K, MEL, NSW).

Astartea sp. Scott River (D.J. Backshall 88233), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002).

Illustration. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002), as *Astartea* sp. Scott River (D.J. Backshall 88233).

Shrub 0.2–1.2 m tall, spindly, often very slender but up to 1 m wide, with long weeping or almost prostrate branches and long fine branchlets, single-stemmed or sometimes multi-branched at base; young (actively growing) stems reddish, scarcely winged; older stems with grey-brown epidermis. *Leaves* appressed to moderately spreading, widely spaced on young rapidly growing stems, usually mostly not in fascicles. *Petioles* 0.3–0.7 mm long, poorly defined and sometimes appearing to be absent. *Leaf blades* straight or slightly incurved, almost linear from side view, 4–12 mm long, 0.2–0.7 mm wide, 0.3–0.8 mm thick, acute, \pm smooth. *Inflorescence* of 1–17 pairs or clusters of flowers per main branchlet, with several pairs in each leaf fascicle on the very short side branchlets and solitary pairs of flowers borne where the pairs of leaves are widely spaced. *Peduncles* 0.3–5 mm long. *Bracteoles* 0.5–3.5 mm long, 0.2–0.35 mm wide, usually green with reddish base and apex, the hooded apex usually with a slender dorsal horn to 0.4 mm long, usually caducous or dehiscent but sometimes persistent at anthesis. *Pedicels* 0.7–2.5 mm long. *Buds* prominently 5-horned. *Flowers* 4–7 mm diam. *Hypanthium* 1–2.5 mm long; adnate portion fairly smooth; free portion 0.3–0.4 mm long. *Outer sepals* 0.7–1.7 mm long including and 0.4–0.7 mm long excluding the very prominent horn, 0.9–1.5 mm wide, the herbaceous portions reddish; scarious margin broad, petal-like, unevenly lacinate-denticulate; horn erect, incurved, 0.9–1.5 mm long. *Petals* 1.6–2.5 mm long, white or pale pink; margin shallowly lacinate-denticulate. *Androecium* of (5–)8–14(–16) stamens, in fascicles of 2–5 opposite several (rarely all) of the sepals and solitary stamens usually opposite at least one sepal and occasionally no stamens opposite one or two of the sepals; filaments connate for up to 0.4 mm, the longest 0.4–1.1 mm long; anthers 0.25–0.4 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 3–9 per loculus. *Style* 0.8–1.5 mm long, the basal 0.3–0.4 mm immersed; stigma 0.1–0.25 mm wide. *Fruits* 3-valvate, 0.7–1.3 mm long, 1.5–2.5 mm diam.; hypanthium shallowly hemispheric-obconic, at least half the length of the fruit; undeveloped ovules/seeds usually white to pale brown but sometimes reddish. *Seeds* up to 4 per loculus, sometimes not developed in all loculi, tending to be fairly erect, reniform to \pm broadly ovoid, 0.6–0.8 mm long, 0.35–0.5 mm thick; testa thin, white to golden brown, usually cream, smooth. (Figure 3G)

Diagnostic features. Single-stemmed or basally branched *shrub* occurring in winter-wet depressions. *Flowers* 4–7 mm diam. *Sepals* prominently horned. *Petals* 1.6–2.5 mm long, white or pale pink. *Stamens* 5–16. *Staminodes* usually absent. *Ovary* 3-locular; ovules 3–9 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERNAUSTRALIA [localities withheld for conservation reasons]: 1988, *D.J. Backshall* DB 88233 (PERTH); 11 Mar. 1997, *R.J. Cranfield* 11059 (PERTH); 20 Jan. 1992, *N. Gibson & M. Lyons* 100 (PERTH); 6 Apr. 1991, *N. Gibson & M. Lyons* 102 (AD, BRI, HO, PERTH); 31 Dec. 1990, *G.J. Keighery* 13464 (PERTH); 20 Feb. 1992, *G.S. McCutcheon* 2457

(PERTH); 2 Jan. 1991, *C.J. Robinson* 426 (PERTH); 5 Jan. 2010, *B.L. Rye* 290111 (NSW, PERTH); 26 Jan. 2001, *J. Scott* 382 (PERTH); 17 Nov. 1982, *A. Strid* 21472 (PERTH); 9 Dec. 1978, *E. Wittwer* W 2261 (PERTH).

Distribution and habitat. Extends from Scott National Park south-east to D'Entrecasteaux National Park (Figure 11A). Found on pale grey sand or sandy clay over clay in seasonally wet sedgeland, mainly on the plains not far from the south coast, such as the Scott River plain. The shrub species present include a number of other myrtaceous species associated with wetlands, such as species of *Taxandria*.

Phenology. Flowering is recorded from late November to March, especially in December and January.

Conservation status. Priority Four under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Scott River (D.J. Backshall 88233) in Smith (2012). This taxon has a fairly restricted distribution but is known from several national parks or nature reserves.

Etymology. From the Greek *onyx* (claw), referring to the claw-shaped horn on each sepal. This species has the most prominently horned sepals in the genus.

Common name. Clawed *Astartea*.

Affinities. A distinctive species, usually easy to recognise by its very slender leaves and the very prominent horns on its sepals. It differs from *A. affinis* in its single-stemmed habit, more slender stems and leaves, and its usually more prominently horned sepals.

Co-occurring taxa. *Astartea onycis* does not appear to occur intermixed with other *Astartea* species very often but has been recorded (*B.L. Rye* 290113) growing close to *A. scoparia* (*B.L. Rye* 290112) at one locality.

Notes. This species is very variable in peduncle length, with extreme variation often on a single plant; for example *R.J. Cranfield* 11059 has peduncles varying from *c.* 0.3 mm where the flowers are densely clustered to 5 mm long on the flush growth. Leaf and flower sizes vary considerably, partly depending upon environmental conditions. Stamen number is very variable; the lowest numbers recorded are 5 or 6 per flower on *A. Strid* 21472, with 0–2 stamens opposite each sepal.

Astartea reticulata Rye, *sp. nov.*

Typus: [north-west of Esperance,] Western Australia [precise locality withheld for conservation reasons], 10 December 2003, *B.L. Rye* 231237 (*holo:* PERTH 06586147; *iso:* CANB, K, MEL).

Astartea sp. Hopetoun area (A.S. George 10594), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Slender *shrub* commonly 0.7–1.5 m tall, single-stemmed at the base or multi-branched at or near the base, sometimes with weeping flowering branches; young (actively growing) stems red-brown, with narrow wings up to 0.2 mm wide; older stems with pale grey epidermis splitting to reveal a reddish brown underlayer. *Leaves* erect to widely spreading, mostly in fascicles, fairly straight. *Petioles* 0.4–0.8 mm long. *Leaf blades* ± narrowly obovate from side view, 4.5–7 mm long, 0.4–0.8 mm wide, 0.5–0.8 mm

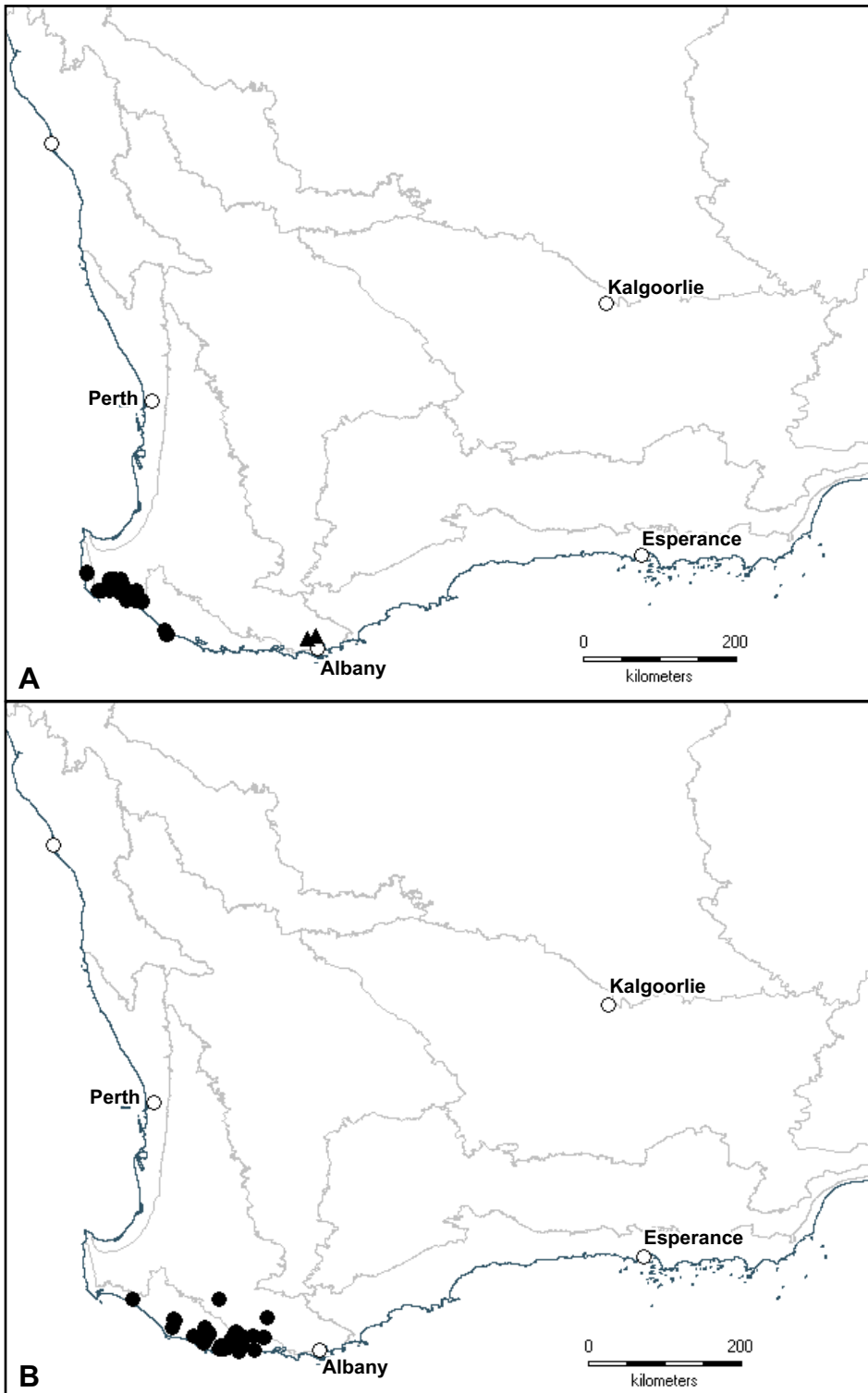


Figure 11. Distributions of *Astartea* species. A – *A. onycis* (●), *A. transversa* (▲); B – *A. schauerii* (●).

thick, acute, somewhat wrinkled-rugose. *Inflorescence* commonly of several pairs of flowers per main branchlet or on each small lateral branchlet. *Peduncles* 3–4.5 mm long. *Bracteoles* 1.3–2.3 mm long, 0.25–0.45 mm wide, with a hooded apex; scarious margins broad, entire. *Pedicels* 1.2–1.5 mm long. *Buds* 5-lobed to 5-toothed. *Flowers* 6–9 mm diam. *Hypanthium* 1.5–2 mm long, up to *c.* 2.5 mm wide; adnate portion usually somewhat broadly 5-ribbed, somewhat rugose and gland-dotted; free portion 0.4–0.6 mm long. *Outer sepals* 0.4–0.6 mm long, 1.2–1.5 mm wide, strongly ridged or very shortly horned; scarious margin entire; horn up to 0.1 mm long. *Petals* 2.2–2.6 mm long, pale pink to white, usually with at least some pink colour; margin entire or nearly so. *Androecium* of 14–21 stamens, in fascicles of 2–5 opposite the sepals; filaments connate for up to 0.5 mm, the longest *c.* 1.2 mm long; anthers *c.* 0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 7–11 per loculus. *Style* 1.5–2 mm long, the basal 0.4–0.5 mm immersed; stigma 0.3–0.4 mm wide. *Fruits* 3-valvate, 1.2–1.7 mm long, usually 2.3–2.5 mm diam.; hypanthium 3-lobed. *Seeds* up to 4 per loculus, irregularly ovoid, 0.9–1.2 mm long, 0.35–0.45 mm wide, 0.4–0.5 mm thick; testa moderately thick, golden brown to greyish brown, with a dark reticulate pattern resulting from darkened cell margins or mottled, with the cell margins slightly raised. *Chaff pieces* dark red-brown.

Diagnostic features. Single-stemmed or basally branched *shrub* associated with winter-wet depressions. *Flowers* 6–9 mm diam. *Outer sepals* very shortly horned or strongly ridged. *Petals* 2.2–2.6 mm long, pale pink or white. *Stamens* 14–21. *Staminodes* usually absent. *Ovary* 3-locular; ovules 7–11 per loculus. *Seeds* with moderately thick testa, partially red or mottled.

Selected specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 27 Feb. 2006, *G.F. Craig* 7083 (PERTH); 2 Dec. 1960, *A.S. George* 1897 (PERTH); 20 Dec. 1970, *A.S. George* 10594 (PERTH); 9 Dec. 2003, *B.L. Rye* 231228 (NSW, PERTH).

Distribution and habitat. Extends from west of Quoin Head in the Fitzgerald River National Park east to near Esperance (Figure 10B). Occurs in winter-wet depressions or near watercourses along the coastal plain, commonly associated with the paperbark species *Melaleuca cuticularis*.

Phenology. Flowers from late November to January.

Conservation status. Priority Three under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Hopetoun area (*A.S. George* 10594) in Smith (2012). Since it was listed, further populations have been located and its known range is now *c.* 170 km long.

Etymology. From the Latin *reticulatus* (net-like), referring to the ornamentation of the seeds.

Co-occurring taxa. *Astartea reticulata* usually occurs alone but has been recorded with *A. cicatricosa*, as noted under that species.

Affinities. Differs from *A. decemcostata* as noted under that species; *A. decemcostata* also tends to have less prominently horned sepals.

Notes. The seed testa is described here as moderately thick as it has the cell margins slightly thickened although the interior of each cell is thin as in most species of *Astartea*.

Astartea schaueri Rye & Trudgen, *sp. nov.*

Typus: Coalmine Beach, Walpole, Western Australia, 1 March 2006, *G.J. Keighery & B.J. Keighery* 737 (*holo*: PERTH 07850425; *iso*: CANB, K, MEL, NSW).

Astartea sp. big bracteoles (A.R. Annels 995), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002).

Illustrations. J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 686, 687 (2002) [as *Astartea* sp. big bracteoles (A.R. Annels 995)].

Shrubs 0.5–1.5(–2) m high, usually low and sprawling, recorded up to 2 m wide, often entangled with other shrubs, producing multiple stems from a lignotuber; young (actively growing) stems narrowly 4-winged or 4-ridged at first; older stems with a smooth, shiny, grey outer layer eventually peeling off to reveal a darker and rougher, grey-brown layer. *Leaves* mostly in fascicles, antrorse to widely spreading, mostly recurved. *Petioles* 0.6–1.2 mm long. *Leafblades* linear in outline, flattened adaxially, 4.5–8 mm long, 0.4–0.7 mm wide, 0.5–0.8 mm thick, acute, relatively smooth. *Inflorescence* usually of several to many pairs of flowers per branchlet, the pairs mostly fairly well separated. *Peduncles* 4–7 mm long. *Bracteoles* 2.4–3.5 mm long, 1–1.7 mm wide, the scarious margin broad, with keel produced into a terminal horn or point; horn recurved distally or erect, 0.4–1.1 mm long. *Pedicels* 1.5–2.5 mm long. *Buds* with 5 prominent erect horns or smaller points and often deep pink petals. *Flowers* 8–11 mm diam. *Hypanthium* 1.4–2.1 mm long, 2.5–3.5 mm diam.; adnate portion irregularly rugose or with oil glands prominent (but not reticulate-pitted), somewhat lobed but scarcely ribbed; free portion 0.4–0.7 mm long. *Outer sepals* 0.6–1.1 mm long including moderate to very prominent horn, 1.4–1.6 mm wide, the herbaceous portions reddish; scarious margin broad, petal-like, almost entire to distinctly denticulate; horn broad-based, distally incurved, 0.3–1 mm long. *Petals* 3–4 mm long, pale pink or white; margin minutely crenulate or entire. *Androecium* of 14–27 stamens, in fascicles of 2–6 opposite the sepals or occasionally with a fascicle reduced to 1 stamen; filaments connate for up to 0.7 mm, the longest 1.2–1.6 mm long; anthers 0.3–0.35 mm long; staminodes absent or rare. *Ovary* 3-locular or 2-locular (but always with 3-locular flowers also present on the same plant); ovules 6–11(12) per loculus. *Style* 1.5–1.8 mm long, the basal *c.* 0.5 mm immersed; stigma 0.3–0.5 mm wide. *Fruits* 3-valvate, 1.8–2 mm long, 2.5–3 mm diam.; hypanthium somewhat 3-lobed; abortive ovules/seeds deep red. *Seeds* up to 5 per loculus but sometimes only 1 or 2 per fruit, 0.9–1.2 mm long, 0.5–0.65 mm thick; testa thin, developing red markings, smooth. (Figures 3H–J; 4F–H)

Diagnostic features. Lignotuberous *shrub* growing in winter-wet depressions. *Flowers* 8–11 mm diam. *Outer sepals* prominently horned. *Petals* 3–4 mm long, pale pink or white. *Stamens* 14–27. *Staminodes* usually absent. *Ovary* 3-locular; ovules 6–12 per loculus. *Seeds* with a thin testa, mottled, smooth.

Selected specimens examined. WESTERN AUSTRALIA: Walpole, Crossing Block Pt 210, 20 Dec. 1989, *A.R. Annels* 995 (PERTH); 500 m off South Coast Hwy, 40 km N of Walpole on road to airstrip, 4 Feb. 1997, *R.J. Cranfield* 10929 (PERTH); Clear Hills Rd, 10.6 km S of Mount Barker–Manjimup road, 18 Jan. 1998, *R. Davis* 4791 (PERTH); on the N boundary of Quarrum Nature Reserve, *c.* 100 m E from Boat Harbour Rd, 9 Jan. 2003, *B.G. Hammersley* 3245 (AD, BRI, PERTH); Break Rd, 1.4 km E of Watershed Rd, 17 Jan. 2003, *B.G. Hammersley* 3256 (PERTH); Middle Rd, 1.4 km S of Boronia Rd, *c.* 13 km E of Mt Frankland, 22 Feb. 1996, *R.W. Hearn* ARA 5714 (PERTH); Bow River, Dec. 1912, *S.W. Jackson s.n.* (CANB, K, PERTH); Broke Inlet Rd, 1.6 km W of Chesapeake Rd, 23 Jan.

2003, B.L. Rye 230173 & R.W. Hearn (AD, BRI, PERTH); W across inlet from Walpole township, c. 10 m from inlet, 13 Feb. 1994, M.E. Trudgen 12042 (PERTH); Nut Rd Lookout, c. 2.3 km N of junction with Ficifolia Rd, Walpole–Nornalup National Park, 28 Jan. 1993, J.R. Wheeler 3836 & S.J. Patrick (PERTH).

Distribution and habitat. Extends along the south coast from near Windy Harbour east to Quarrum Nature Reserve and near Denmark River (Figure 11B). Occurs in depressions between the more stable coastal dunes and in low-lying, seasonally damp areas. Associated species include a variety of other *Astartea* species and many other wetland species such as *Agonis juniperina*, *Beaufortia sparsa* and *Homalospermum firmum*.

Phenology. Flowers mainly mid-December to early February.

Conservation status. Not currently considered to be at risk, as it has a range c. 120 km long. It occurs in one fairly large national park and at least one nature reserve.

Etymology. Named in honour of the German botanist Johannes Conrad Schauer (1813–1848), who made an impressive contribution in delimiting and naming new species of *Astartea*. He also named many other Australian species of Myrtaceae and also a number of new genera.

Co-occurring taxa. *Astartea schaueri* rarely occurs on its own, perhaps because its habitat and range correspond with the main area of occurrence of the genus. Species that have been found growing with it include *A. arbuscula*, *A. glomerulosa*, *A. laricifolia* and *A. scoparia*. See the notes under *A. scoparia* regarding possible hybrids.

Affinities. *Astartea schaueri* appears to be related to two other lignotuberous species, *A. corniculata* and *A. middletonii*, all three taxa having mottled seeds and prominently horned sepals. Relatively large-flowered specimens could be confused with *A. middletonii*, which has the largest flowers in the genus. *Astartea middletonii* differs from *A. schaueri* in its granitic habitat, its longer, more terete leaves and more numerous stamens.

Smaller-flowered specimens of *A. schaueri* could be confused with *A. corniculata*, which is a smaller plant with fewer ovules and smaller leaves, flowers and fruits.

Notes. Although *A. schaueri* has been known informally as *A. sp. big bracteoles* (A.R. Annels 995), its bracteoles are quite variable in size, not consistently very large as in *A. granitica* and *A. middletonii*.

Astartea scoparia Schauer in J.G.C. Lehmann, *Pl. Preiss.* 1: 114 (1844). *Type:* ‘In solo-arenoso secundum fl. Cygnorum supra vicum Perth’ [sandy soil along Swan River near Perth, Western Australia], February and April, *L. Preiss* (Herb. Preiss No.) 150 *ex parte* (*holo:* LD; *iso:* MEL 2147397).

Astartea sp. Juniperina (G.J. Keighery 9558), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002).

Illustrations. N.G. Marchant, J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane, *Fl. Perth Region* 1: 381, Figure 140 (1987) [as *A. fascicularis*]; J.R. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 688 (2002) [as *A. sp. Juniperina* (G.J. Keighery 9558)].

Shrub 1–3 m high, with a lignotuber; young (actively growing) stems red-brown, often with narrow wings up to 0.25 mm wide; older stems developing a pale grey epidermis. *Leaves* mostly in fascicles, strongly recurved to fairly straight. *Petioles* 0.4–0.8 mm long. *Leaf blades* narrowly obovate to linear from side view, 4–10 mm long, 0.4–0.6 mm wide, 0.4–0.7 mm thick, acute. *Inflorescence* usually of many well spaced pairs or clusters of flowers along the main flowering branches, the clusters consisting of several pairs of flowers on short lateral branchlets with leaf fascicles. *Peduncles* 1.5–3.5 mm long. *Bracteoles* 1–2.5 mm long, 0.25–0.4 mm wide; apex acute or hooded, sometimes with a slight dorsal subterminal point. *Pedicels* 2–4 mm long. *Buds* somewhat 5-lobed. *Flowers* 6–9 mm diam. *Hypanthium* 1.5–2 mm long, 2–2.3 mm diam.; adnate portion gland-dotted and often somewhat rugose; free portion 0.4–0.5 mm long. *Outer sepals* 0.4–1 mm long, 0.9–1.3 mm wide, smooth or slightly ridged dorsally; scarious margin entire. *Petals* 2–3 mm long, white; margin entire or nearly so. *Androecium* of usually 20–40 stamens, in fascicles of 3–11 opposite the sepals; filaments connate for up to 0.5 mm, the longest 1–1.2 mm long; anthers 0.15–0.25 mm long; staminodes absent or rare. *Ovary* 3-locular; ovules 3–8 per loculus. *Style* 1.3–1.6 mm long, the basal 0.25–0.3 mm immersed; stigma 0.25–0.35 mm wide. *Fruits* 3-valvate, 1.4–1.8 mm long, 2–2.5 mm diam.; hypanthium usually somewhat 3-lobed. *Seeds* 0.6–0.9 mm long, 0.35–0.6 mm thick; testa thin, off-white or pale brown, smooth. (Figure 1F)

Diagnostic features. Medium to tall, lignotuberous *shrub* associated with winter-wet depressions. *Flowers* 6–9 mm diam. *Sepals* smooth or slightly ridged. *Petals* 2–3 mm long, white. *Stamens* usually 20–40. *Staminodes* usually absent. *Ovary* 3-locular; ovules 3–8 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimens examined. WESTERN AUSTRALIA: 19 km E of Walpole, Walpole–Nornalup National Park, 17 Dec. 1987, *A.R. Annels* 227 (PERTH); behind first dune east of where Inlet River enters Broke Inlet, 19 Dec. 1994, *A.R. Annels* 5236 & *R.W. Hearn* (PERTH); boat harbour, Denmark, 25 Feb. 1966, *A. Fairall* 2194 (PERTH); Torndirrup National Park, 13 Dec. 1990, *N. Gibson & M. Lyons* 108 (PERTH); Gnangara Pine Plantation, along Central way [Centre Way] from Gnangara Rd, 24 Nov. 1994, *E.D. Kabay* 1170 (PERTH); nature reserve on Great Northern Hwy just N of Rutland Rd, 8 Dec. 1994, *E.D. Kabay* 1241 (PERTH); Mialla Lagoon, 31 Mar. 1995, *B.J. Keighery* 2001 (PERTH); E side of Scott National Park, 5 Feb. 1997, *G.J. Keighery* 14586 (PERTH); interdunal area, Bunbury airport, 6 km SE of Bunbury on Boyanup Rd, 7 Jan. 1999, *G.J. Keighery* 15597 (PERTH); Collie basin, 13 Jan. 1981, *J. Koch* CJK 519 (PERTH); intersection of Bibbulmun track and Allen Rd, SE of Mundaring Weir, 6 Dec. 2000, *K. Macey* 312 (PERTH); Lake Muir, *T. Muir s.n.* (MEL); Boodjidup Brook, 2 Apr. 1991, *C.J. Robinson* 530 (PERTH); 4.8 km W along the road that turns off 1.2 km S of Regans Ford, 10 Sep. 1975, *M.E. Trudgen* 1437, *M. Clarke & A. Travers* (PERTH); next to flow line in the valley of the Southern River, at corner of Southern River Rd and Bullfinch Rd, Huntingdale, 24 Dec. 1994, *M.E. Trudgen* 12193 (PERTH).

Distribution and habitat. Grows on coastal plains and adjacent hills around the south-west coast from Moore River to Albany, extending inland to the Kojonup area (Figure 12A). It occurs mainly in sandy, peaty soils in seasonally wet flats or depressions, sometimes dominated by *Melaleuca preissiana* or *Banksia littoralis*, or along small watercourses.

Phenology. Flowers mainly from December to March, beginning in late November in the north of its range and tending to flower later in the south, with occasional records at other times.

Conservation status. Not currently considered to be at risk; this is the most widespread of all *Astartea* species and is protected in several national parks as well as many nature reserves.

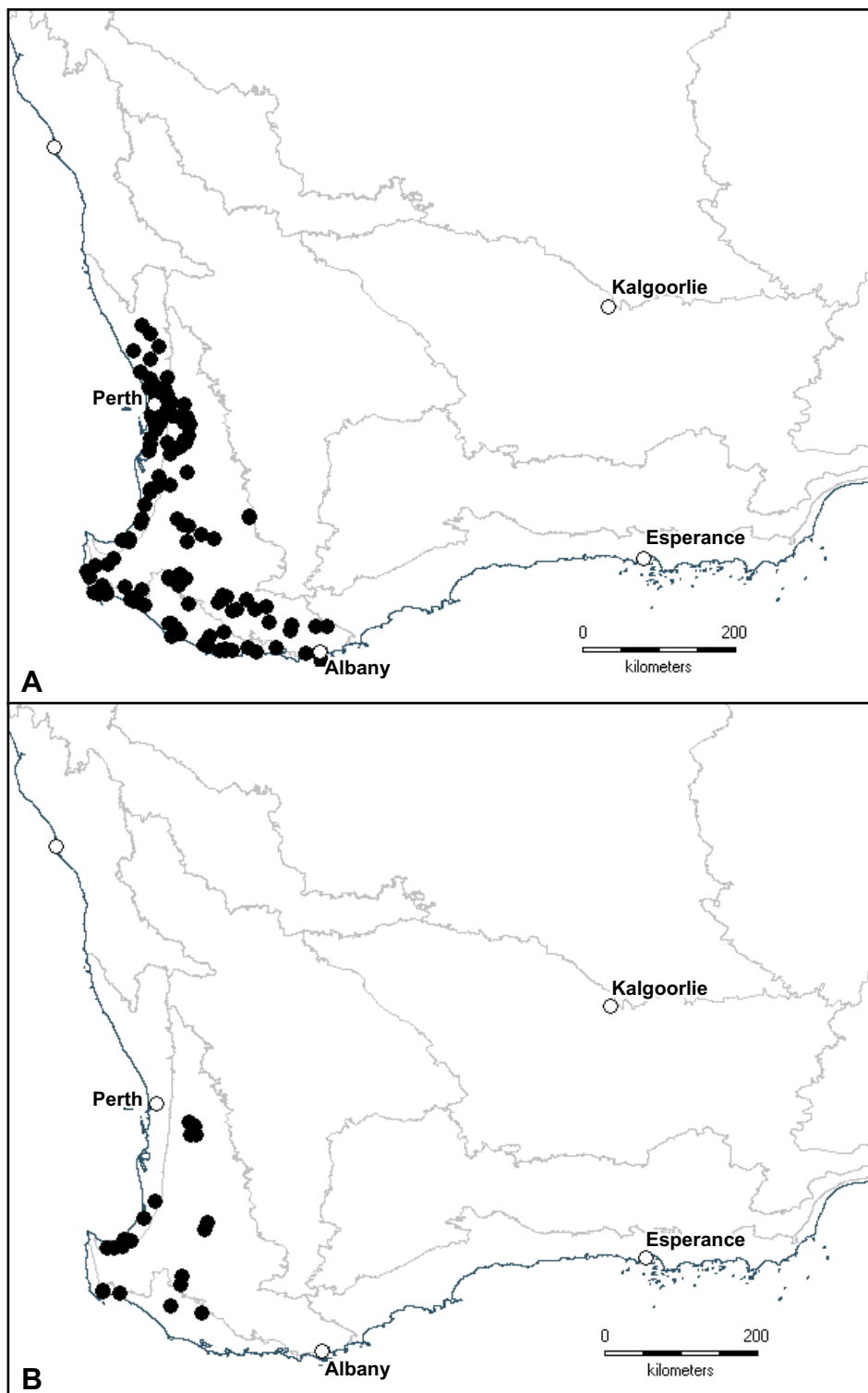


Figure 12. Distributions of *Astartea* species. A – *A. scoparia* (●); B – *A. zephyra* (●).

Etymology. From the Latin *scoparius* (thin twigs), in reference to its broom-like habit.

Common name. Common Astartea.

Affinities. Probably closely related to *A. leptophylla*, a riverine species with a different habit, lacking a lignotuber, and usually with longer, finer leaves. Another relative, *A. zephyra*, differs in its usually fewer stamens and ovules, and its functionally 1- or 2-locular ovaries.

Co-occurring taxa. This widely distributed species has been recorded with many other *Astartea* species. *Astartea scoparia* probably hybridises with *A. schaueri*; somewhat intermediate specimens with pale pink flowers were found in a mixed population of these two species near Broke Inlet (*B.L. Rye* 230165–230170 & *R.W. Hearn*). See also the notes under *A. affinis*, *A. glomerulosa*, *A. onycis* and *A. zephyra*.

Notes. The type specimen of *A. scoparia* from along the Swan River has fascicles of short and distinctly recurved leaves and young stems with a delicate-looking, grey epidermis dotted with small, dark glands, matching the stems of many of the specimens from the Perth area and nearby. Many specimens from the Perth region also have strongly recurved leaves (e.g. *M.E. Trudgen* 10753 & 10752).

This widespread and variable species is in cultivation in Western Australia and is possibly now naturalised in eastern Australia.

Astartea transversa Rye, *sp. nov.*

Typus: north-north-east of Albany, Western Australia [precise locality withheld for conservation reasons], 9 May 1986, *G.J. Keighery* 8063 (*holo:* PERTH 00995886; *iso:* CANB).

Astartea sp. Millbrook (*G.J. Keighery* 8063), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012].

Illustration. An unpublished illustration by Sue Patrick is lodged at the DEC library.

Low dwarf or small *shrub*, 0.1–0.4 m high, often much broader than tall, usually widely spreading, fairly dense, often with decumbent branches, probably single-stemmed at base; young (actively growing) stems reddish, not winged; older stems with pale grey epidermis splitting irregularly to reveal a brown underlayer. *Leaves* often in alternating whorls of 3 but always with some opposite-decussate ones, tending to be in fascicles on the lower parts of main branchlets, on newer growth mostly not in fascicles, mostly widely spreading. *Petioles* 0.2–0.4 mm long, poorly or well defined. *Leafblades* straight, slightly incurved, narrowly obovate in outline, 2–2.5 mm long, 0.3–0.5 mm wide, 0.4–0.6 mm thick, obtuse, usually with a distinct mucro, somewhat rugose. *Inflorescence* of up to 12 or more pairs or triplets of flowers per main branchlet. *Peduncles* usually fairly straight or somewhat recurved, 0.3–1.3 mm long. *Bracteoles* ± narrowly ovate, 0.5–0.7 mm long, 0.15–0.3 mm wide; scarious margins fairly narrow, entire; apex acute, with midrib terminating in a mucro. *Pedicels* absent or less than 0.3 mm long. *Buds* with a somewhat 5-toothed apex. *Flowers* c. 2 mm diam., slightly zygomorphic with respect to the hypanthium and gynoecium. *Hypanthium* with adaxial surface compressed, 0.6–0.7 mm long, 0.8–1 mm wide; adnate portion tuberculate-rugose and gland-dotted; free portion 0.2–0.3 mm long. *Outer sepals* 0.2–0.35 mm long, 0.3–0.5 mm wide, dorsally ridged; scarious margin minutely lacinate or entire. *Petals* 0.5–0.7 mm long, white or pale pink; margin somewhat irregular. *Androecium* of 3–5

stamens, with 1 or none opposite each sepal; filaments free, 0.2–0.3 mm long; anthers 0.15–0.2 mm long; staminodes absent. *Ovary* functionally 1-locular, with one extremely reduced abortive loculus in addition to the fertile loculus; ovules 1 or 2. *Style* often displaced towards one side of the ovary, 0.6–0.7 mm long, the base slightly immersed or not immersed; stigma up to *c.* 0.15 mm wide. *Fruits* indehiscent, somewhat lop-sided, largely inferior, the abaxial surface flattened and the remainder convex, *c.* 0.6 mm long, *c.* 0.7 mm wide; hypanthium rugose-tuberculate. *Seed* solitary as far as known, transversely orientated, broadly reniform, *c.* 0.6 mm long, *c.* 0.5 mm thick, with pale brown with dark reddish markings, smooth. (Figures 2B; 3K; 4I)

Diagnostic features. Small *shrub* growing in swamps. *Flowers* *c.* 2 mm diam. *Outer sepals* ridged. *Petals* 0.5–0.7 mm long, white or pale pink. *Stamens* 3–5. *Staminodes* absent. *Ovary* functionally 1-locular; ovules 1 or 2 per loculus. *Seed* with a thin testa, mottled, smooth.

Selected specimens examined. WESTERNAUSTRALIA [localities withheld for conservation reasons]: 7 Apr. 1985, *E.A. Griffin* 4073 (PERTH); 15 May 1986, *G.J. Keighery* 8398 (PERTH).

Distribution and habitat. Occurs north-east of Albany (Figure 11A). Recorded on grey sand or peaty black sandy clay on winter-wet flats in heath.

Phenology. Flowering is recorded in January and from early April to June.

Conservation status. Priority Two under DEC Conservation Codes for Western Australian Flora; listed as *A. sp.* Millbrook (*G.J. Keighery* 8063) in Smith (2012). Known from a single nature reserve.

Etymology. From the Latin *transversus* (crosswise), referring to the unusual horizontal orientation of the seed in this species.

Affinities. This is one of the few species in the genus that has an indehiscent, somewhat lop-sided fruit with the style base scarcely inset. It was previously included in *A. arbuscula* because of its minute flowers with very few short stamens (never more than one opposite each sepal). However, it has a different overall appearance with the leaves much more clustered. While its leaves tend to be shorter and more club-shaped, its flowers tend to be larger, with a longer style. It also differs significantly from *A. arbuscula* in its hypanthium and fruit shape and its seed orientation, shape and colouring. In those characters it is more similar to *A. corniculata*, which may be its closest relative. *A. corniculata* differs in its horned sepals and more numerous, longer stamens and functionally 2(3)-locular ovary.

Co-occurring taxa. The only other *Astartea* species that has been collected in the reserve is *A. corniculata*, but the vegetation for the *G.J. Keighery* 8398 collection of *A. transversa* was recorded as ‘*Astartea* over heath’, suggesting that at least one larger-sized species of *Astartea* was also present.

Notes. This appears to be the only species of *Astartea* that commonly has leaves and flowers in whorls of three, and its average stamen number is the lowest in the genus. It also seems to be unique in that its solitary seed is always transversely orientated in the indehiscent fruit (Figure 4I). The seed is closer to reniform than in other species of *Astartea* as the inner surface is more curved and both ends are equally wide, although the end distal to the hilum is distinctly thinner than the basal end, being dorsiventrally compressed. The normal seed shape in *Astartea* is more ovoid with the distal end tapering both laterally and dorsiventrally.

A photograph of this species [as *Baেকেa arbuscula*] in Hopper *et al.* (1990) demonstrates the minute size of its flowers, using a match head for scale.

Astartea zephyra Rye & Trudgen, *sp. nov.*

Typus: 2.5 km south of Brookton Highway on Leona Road, Western Australia, 30 December 2004, B.L. Rye 241204, F. Hort & J. Hort (*holo*: PERTH 07581661; *iso*: CANB, K, MEL, NSW).

Astartea sp. Gingalup (N. Gibson & M. Lyons 119), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000); J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002).

Illustration: J. Wheeler, N. Marchant & M. Lewington, *Fl. South West* 2: 687 (2002), as *Astartea* sp. Gingalup (N. Gibson & M. Lyons 119).

Slender *shrub*, usually erect but sometimes low and spreading, (0.2–)0.5–1.5(–2) m tall, with a lignotuber and long slender branchlets; young (actively growing) stems greenish to orange-brown, not winged; older stems with a smooth, grey outer layer shedding to reveal an orange-brown underlayer. *Leaves* antrorse to widely spreading, all distant or often also some of them in fascicles along the main branchlets or at the apex of the branchlets. *Petioles* 0.4–0.8(–1) mm long. *Leafblades* linear to narrowly obovate from side view, 4–10 mm long, 0.5–1 mm wide, 0.6–0.9 mm thick, obtuse. *Inflorescence* usually with 1 or 2 pairs of flowers per leaf fascicle, with up to *c.* 20 pairs along a main branchlet. *Peduncles* 0.7–3 mm long. *Bracteoles* 0.6–0.8 mm long, *c.* 0.3 mm wide, ridged on the hooded apex, the herbaceous part orange-brown or reddish; scarious margins broad. *Pedicels* 0.3–1.5 mm long. *Buds* ± truncate. *Flowers* 3.5–5 mm diam., often slightly zygomorphic with respect to the gynoeceum. *Hypanthium* 1.2–1.8 mm long; adnate portion 5-ridged, fairly smooth or minutely irregularly rugose-pitted, the oil glands minute and often inconspicuous; free portion 0.2–0.4 mm long. *Outer sepals* 0.4–0.7 mm long, 0.8–1.3 mm wide, rugose but scarcely ridged dorsally, largely herbaceous and reddish; scarious margin very narrow. *Petals* (1.2–)1.3–1.7 mm long, white or pale pink; margin distinctly irregular to entire. *Androeceum* of 7–20 (often 10) stamens, in fascicles of 2–5 opposite at least two of the sepals and with solitary stamens opposite up to three sepals; anthers 0.25–0.3 mm long; filaments of fascicles connate for up to 0.3 mm, the longest 0.6–1.1 mm long; staminodes absent or rare. *Ovary* 2-locular but often functionally 1-locular, with adaxial loculus often smaller than the abaxial one or abortive; ovules usually 1–6 per loculus. *Style* often displaced towards the adaxial side of ovary, 1.2–1.5 mm long, the basal 0.1–0.2 mm immersed; stigma *c.* 0.15 mm wide. *Fruits* indehiscent, often somewhat lop-sided, 1.3–1.4 mm long, 1.4–1.6 mm wide; hypanthium longer and becoming more rounded on the abaxial edge than the adaxial one; abortive ovules/seeds dark red-brown. *Seeds* solitary or few per fruit, usually obliquely erect, irregularly narrowly ovoid or ovoid, 0.9–1.3 mm long, 0.4–0.5 mm thick; testa thin, cream to golden brown, smooth.

Diagnostic features. Lignotuberous *shrub* growing in winter-wet depressions. *Flowers* 3.5–5 mm diam. *Outer sepals* scarcely ridged. *Petals* 1.2–1.7 mm long, white or pale pink. *Stamens* 7–20. *Staminodes* usually absent. *Ovary* functionally 1- or 2-locular; ovules usually 1–6 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected 1-locular specimens examined. WESTERN AUSTRALIA: Mill Rd, G07164 on Donnelly River, 28 Dec. 1983, A.R. Anells 1764 (PERTH); McAlinden Rd, 3.5 km SW of Trigwell Bridge Rd, SW of Bowelling, 16 Feb. 1995, V. Crowley & J. Smith DKN 428 (PERTH); Brady State Forest,

Leona Rd, 2.45 km S of Brookton Hwy, Shire of Wandering, 15 Jan. 2004, *F. Hort & J. Hort* 2165 (PERTH); SW corner of Fish Rd Reserve, 13 km SW of Busselton, 3 Jan. 1991, *B.J. Keighery* 1991/1 (PERTH); W of Ruabon, 2.5 km along Wonnerup Rd, 3 Jan. 1991, *B.J. Keighery* 1991/2 (PERTH); Ranger Swamp, 2 km W of Bengier between Harvey and Brunswick, 15 Dec. 1985, *G.J. Keighery* 8369 (PERTH); 1.8 km along Curtin Rd from Creekbend Rd, 19 Mar. 1997, *K. Kershaw & C. Day* P 97.11 (PERTH); Blackwood River, 10 Dec. 1877, *F. Mueller s.n.* (MEL 76016); Pemberton District, Jan. 1972, *F.G. Smith* 2167 (PERTH); South Western Hwy, 0.45 km N of Cosy Creek Rd intersection, 5.65 km N of Manjimup town centre, 23 Jan. 2003, *B.L. Rye* 230156 & *R.W. Hearn* (PERTH); 7.9 km SE of Kinsella Rd, on S side of Brookton Hwy, 30 Dec. 2004, *B.L. Rye* 241203, *F. Hort & J. Hort* (AD, BRI, PERTH).

Selected 2-locular specimens examined. WESTERNAUSTRALIA: Scott River, along margin, 29 Dec. 1957, *D.M. Churchill s.n.* (PERTH); W edge of Gingalup Swamp Nature Reserve on firebreak, 25 Oct. 1990, *N. Gibson & M. Lyons* 119 (PERTH); 2 km ENE of Mt Cuthbert, 11 Jan. 2005, *F. Hort, J. Hort & L. Boyle* 2472 (CANB, MEL, PERTH); 1 km along Molloy Island from landing towards Kudardup, 13 Feb. 1978, *G.J. Keighery* 1553 (PERTH, NSW).

Distribution and habitat. Extends from east of Canning Dam in the Darling Range south-west to near Augusta and south to the Pemberton area, in sandy and/or clayey soils, sometimes over ironstone or laterite, in winter-wet areas, often with *Melaleuca* open woodland or heath (Figure 12B). The western variant (see below) is recorded from the margin of a river as well as from winter-wet depressions.

Phenology. Flowers from late November to mid-March, especially in December and January.

Etymology. Named after the Greek god Zephyros, the West Wind, as this species is restricted to the western part of the distribution of its genus.

Conservation status. As a whole this species does not appear to be at risk at present, having a range more than 250 km long, but some of its variants may be geographically restricted.

Co-occurring taxa. In the far south of its range, *A. zephyra* overlaps with several species such as *A. laricifolia* and *A. onycis* but there are no records of it growing with those species. It probably does occur with *A. scoparia* in a number of sites, and it is possible that some of the variation seen within *A. zephyra* results from hybridisation with that species (see below).

Affinities. *Astartea zephyra* appears to differ from all or most other members of the genus in its apparent lack of susceptibility to *Callococcus* infection (see *Insect associations* section). Its closest relative might be *A. scoparia*, which has 3-locular, valvate fruits.

Notes. The number of functional loculi in the ovary is either one or two. In most populations, there is only one functional loculus and the somewhat lop-sided fruits are usually 1-seeded. In these populations the fruit appears to be indehiscent.

Populations in the far south-west, between the Whicher Range and Scott River, have functionally 2-locular ovaries and the multi-seeded fruits appear to be dehiscent, although they may vary in this character or be only tardily dehiscent. However, specimens from the Jarrahdale area (e.g. *F. Hort, J. Hort & L. Boyle* 2469) also have 2-locular fruits, and these are definitely dehiscent. Populations in this northern area are very variable and some specimens have much larger numbers of stamens and

ovules than normally found in *A. zephyra*, suggesting that they may have arisen by hybridisation, perhaps with *A. scoparia*. Another 2-locular specimen (*B.L. Rye* 230156 & *R.W. Hearn*) from near Manjimup occurs in a site with very variable specimens including some typical of *A. scoparia* and hence could be a hybrid.

Plants from the Whicher Range area need further study as a 2-locular specimen (*D. Cooper* 162) from there is atypical in having a few 2-pedunculate axils and in having more numerous ovules than are known in any other specimens of the species. Of the 1-locular specimens, *B.G. Keighery* 1991/1 is atypical in having the stamens all in fascicles, often with 4 or 5 per fascicle.

Despite the high degree of variation in ovary and fruit characters in *A. zephyra*, some characters such as bracteole length are fairly consistent throughout the range of the species.

Presumed hybrids

Hybridisation may be more common in *Astartea* than in most other genera of the tribe Chamelaucieae. One apparent hybrid is described below because it appears to have arisen between two parent species of strikingly different appearance, giving it as distinctive an appearance as is found in most species of *Astartea*, and because it is the only presumed hybrid to have been studied in any detail.

Astartea arbuscula × *corniculata*

Small *shrub* *c.* 0.3 m tall, dense, with multiple stems from a lignotuber up to *c.* 90 mm wide; young (actively growing) stems reddish, not or scarcely winged; older stems with pale grey epidermis splitting irregularly to reveal a brown underlayer. *Leaves* antrorse to widely spreading, mostly not in fascicles, almost straight or slightly incurved. *Petioles* 0.3–0.5 mm long. *Leaf blades* narrowly or very narrowly obovate in outline, 2.5–3.5 mm long, 0.35–0.5 mm wide, 0.4–0.6 mm thick, acute or almost acute, mucronate, smooth or somewhat rugose. *Inflorescence* of usually 2–8 well spaced pairs of flowers per main branchlet or of 1 or several pairs clustered on side branchlets. *Peduncles* slightly to strongly recurved, 1.5–3 mm long. *Bracteoles* 0.6–0.9 mm long, *c.* 0.1 mm wide, rather scarious and reddish throughout, entire; apex somewhat hooded, with midrib terminating in a short point. *Pedicels* 0.3–0.5 mm long. *Buds* with a 5-toothed apex. *Flowers* 3–4 mm diam. *Hypanthium* *c.* 1 mm long, *c.* 1.2 mm wide; adnate portion irregularly broadly ribbed opposite the sepals and slightly pitted-rugose, with minute oil glands; free portion *c.* 0.2 mm long. *Outer sepals* 0.3–0.4 mm long, 0.5–0.7 mm wide, very ridged or very shortly horned; scarious margin fairly narrow, laciniate; horn up to 0.2 mm long. *Petals* 0.8–1.5 mm long, deep pink; margin irregularly laciniate. *Androecium* of 8–12 stamens, 1–4 opposite each of the sepals; filaments connate for up to *c.* 0.2 mm, the longest 0.5–0.6 mm long; anthers *c.* 0.2 mm long; staminodes absent. *Ovary* functionally 1-locular, with a very reduced, abortive adaxial loculus and a fertile abaxial loculus; ovules usually 2 or 3, rarely 4. *Style* 0.6–0.8 mm long, the base scarcely immersed; stigma *c.* 0.1 mm wide. *Fruits* indehiscent, somewhat lop-sided, *c.* 0.7 mm long, *c.* 1.1 mm wide. *Seed* 1, irregularly ovoid, 0.6–0.7 mm long, *c.* 0.35 mm thick, cream to golden brown, smooth.

Diagnostic features. Lignotuberous *shrub* occurring in winter-wet depressions. *Flowers* 3–4 mm diam. *Outer sepals* strongly ridged to shortly horned. *Petals* 0.8–1.5 mm long, deep pink. *Stamens* 8–12. *Staminodes* absent. *Ovary* functionally 1-locular; ovules 2–4 per loculus. *Seeds* with a thin testa, uniformly coloured, smooth.

Selected specimen examined. WESTERN AUSTRALIA [locality withheld for conservation reasons]: 14 Jan. 2003, B.G. Hammersley 3249 (CANB, MEL, PERTH).

Distribution and habitat. Occurs close to the coast in the Denmark–Albany area. Recorded from peaty sandy soil in winter-wet depressions with low shrubs and sedges (Figure 7A).

Phenology. Flowers recorded from late December to mid-January.

Conservation status. This taxon has been described from a single, very mature plant on a nature reserve. Being lignotuberous, this plant will probably be able to survive for many more years. However, as there is no evidence that *A. arbuscula* × *corniculata* is self-perpetuating, it cannot be given any conservation status.

At another locality closer to Albany, where there is a similar mixture of *Astartea* species, varied specimens, including one with deep pink flowers that somewhat resembled the hybrid, were collected by Ellen Hickman on 17 January 2001. No specimens from this collection have been lodged at PERTH but a similar specimen with deep pink flowers (*B.L. Rye* 290143) was collected from the site in 2009. These specimens tend to have larger flowers, longer leaves and larger ovule numbers than the presumed hybrid at Denmark, and might have had a different origin.

Notes. When Brenda Hammersley (pers. comm.) collected *A. arbuscula* × *corniculata* near Denmark in January 2001 she observed that it was very rare, with only one or possibly two plants present, and that it was growing intermixed with *A. arbuscula*. Later surveys of the site in December 2002 and January 2003 revealed that there was only one plant of *A. arbuscula* × *corniculata* present, growing close to single-stemmed dwarf plants 0.1–0.2 m high of *A. arbuscula* (*B.L. Rye* 221249 & 230134, *R.W. Hearn* & *B.G. Hammersley*) and distinctly taller, lignotuberous plants 0.3–0.5(–0.8) m high of *A. corniculata* (*B.L. Rye* 221250 & 230136, *R.W. Hearn* & *B.G. Hammersley*). All three taxa were in the low vegetation across the centre of the swamp; they were not yet in flower in early December, but from late December to mid-January *A. corniculata* produced pale or very pale pink flowers, which were much larger than the deep pink flowers of *A. arbuscula*. *Astartea arbuscula* × *corniculata* had deep pink flowers of the same colour as those of *A. arbuscula* but much more obvious because of their larger size, intermediate between the sizes of the flowers of the two putative parents.

A comparison of the presumed hybrid and the variants of its parent species that co-occur with it (Table 1) shows that *A. arbuscula* × *corniculata* resembles each parent in some characters but is intermediate between them in other characters. It resembles *A. arbuscula* in its branching pattern, lack of leaf fascicles, flower colour, functionally 1-locular ovary, indehiscent fruit and uniformly coloured seeds. Its fewer similarities to *A. corniculata* include the lignotuberous habit, peduncle length and numbers of ovules per loculus. It is intermediate in having very short horns on the sepals, and in many quantitative states such as flower size and stamen number.

Table 1. Comparison of the presumed *Astartea* hybrid and its parent species.

	A. arbutiflora	A. arbutiflora × corniculata	A. corniculata
Height	0.1–0.2 m	0.3 m	0.3–0.5(–0.8) m
Lignotuber	absent	present	present
Leaf fascicles	absent	absent	present
Peduncle length	0.5–1.5 mm	1.5–3 mm	1.5–3.5 mm
Bracteole length	0.3–0.45 mm	0.6–0.9 mm	1.2–2 mm
Pedicle length	0–0.3 mm	0.3–0.5 mm	1.3–1.8 mm
Sepal horn	absent	0–0.2 mm	0.4–1 mm
Flower diameter	1.5–2 mm	3–4 mm	(4–)4.5–6 mm
Petal length	0.4–0.6 mm	0.8–1.5 mm	1.7–2.5 mm
Petal colour	deep pink	deep pink	pale pink
Stamen number	5	8–12	15–20
Functional loculi	1	1	2
Ovules per loculus	1	2–4	2–5
Style length	0.4–0.6 mm	0.6–0.8 mm	1.2–1.6 mm
Fruit	indehiscent	indehiscent	dehiscent
Seed colour	uniformly pale	uniformly pale	mottled

Doubtful names

1. *Astartea fascicularis* var. *brachyphylla* Domin, *Vesnt. Král. České Spolecn. Nauk. Tr. Mat.-Prir.* 1921/2, 2: 83–84 (1923). *Type*: sand plains about Warrungup [Mt Trio, Stirling Range], Western Australia, *A.A. Dorrien-Smith (n.v.)*.

Notes. The type of var. *brachyphylla* has not been examined but it probably matches either *A. montana* or the material currently housed as *A. sp.* southern ranges (T.E.H. Aplin 2108).

2. *Astartea margarethae* Trudgen ms., Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed July 2012]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 345 (2000).

Notes. No specimen has ever been attached to this name, only a note that the taxon was 2 m high and occurred on loam over laterite. It appears to have arisen by mistake, being a mis-recording of the manuscript name *Baeckea margarethae* Trudgen ms. (M. Trudgen pers. comm.).

3. *Leptospermum dubium* Spreng., *Syst. Veg.* 2: 492 (1825). *Type*: Nov. Holl.

Notes. Much of Sprengel's herbarium, apparently including the Myrtaceae, was acquired by Berlin (B) in 1890 and is no longer extant (Stafleu & Cowan 1985: 806). Even if there is still type material in existence, it may well be difficult to link it conclusively with this name. Although he did not see the type specimen, Schauer (1843: 115) considered *Leptospermum dubium* to be synonymous with *Baeckea affinis*. It is unclear how he came to this conclusion as the protologue of *L. dubium* is much too brief and lacking in detail to be used alone to determine the taxon's identity.

Excluded names

As noted in the introduction, two named species that were previously included in *Astartea*, *A. ambigua* and *A. heteranthera*, have been transferred to *Cyathostemon* and another two, *A. clavifolia* and *A. intratropica* have been transferred to *Seorsus*.

The following informal names apply to species that are now considered to belong in the genus *Cyathostemon*: *A. sp.* Bungalbin Hill (K.R. Newbey 8989), *A. sp.* Esperance (A. Fairall 2431), *A. sp.* Fitzgerald (K.R. Newbey 10844), *A. sp.* Jyndabinbin Rocks (K.R. Newbey 7689), *A. sp.* Mt Dimer (C. McChesney TRL4/72) and *A. sp.* Red Hill (K.R. Newbey 8462).

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