

Taxonomic resolution of infraspecific taxa in *Lambertia orbifolia* (Proteaceae) using molecular and morphological evidence

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Abstract

Wege, J.A., Monks, L.T., Webb, A.D., Binks, R.M. & Coates, D.J. Taxonomic resolution of infraspecific taxa in *Lambertia orbifolia* (Proteaceae) using molecular and morphological evidence. *Nuytsia* 34: 125–137 (2023). The taxonomy of three informally-named, conservation-listed subspecies of *Lambertia orbifolia* C.A.Gardner was assessed using genotypic data generated from microsatellites in concert with morphological information. They were found to warrant formal taxonomic recognition and individualised conservation management. *Lambertia orbifolia* subsp. *vespera* A.D.Webb, L.Monks & Wege, an Endangered taxon from the Scott River Plains, and *L. orbifolia* subsp. *pecuniosa* A.D.Webb, L.Monks & Wege, a recently discovered and apparently rare taxon from south-west of Bowelling, are newly described and comparative data are provided for *L. orbifolia* subsp. *orbifolia*, a Critically Endangered taxon found near Narrikup. A revised description of *L. orbifolia* is also provided.

Introduction

Lambertia orbifolia C.A.Gardner (Proteaceae) was described from a single specimen collected in 1962 by Alfred J. Grey from near Albany in Western Australia (Gardner 1964). Its circumscription was subsequently expanded to include a population on the Scott River Plain near Augusta, discovered by Robert D. Royce in 1945, and one from near Narrikup, discovered by Ken R. Newbey in 1964 (George 1984; Hnatiuk 1995; Western Australian Herbarium 1998–). It was listed as Declared Rare Flora in November 1980 under the *Western Australian Wildlife Conservation Act 1950* (Luu & English 2004), at which time only two extant regional population groups (Narrikup and Augusta) were known.

Genetic variation across the range of *L. orbifolia* was investigated in the late 1990s in response to ongoing declines in habitat quality and plant number, and persistent threats to its survival including land clearing, dieback disease caused by *Phytophthora cinnamomi*, aerial canker (*Cryptodiaporthe* sp., *Diplodina* sp.), weed invasion and mining-related activities. Analyses of isozyme, chloroplast DNA and nuclear ribosomal DNA variation revealed a very high level of genetic divergence between the two regional population centres that pointed to two distinct, historically isolated evolutionary

lineages (Byrne *et al.* 1999; Coates & Hamley 1999). Based on these data, populations from the Augusta region were added to Western Australia's vascular plant census in September 1999 under the informal phrase name *L. orbifolia* subsp. Scott River Plains (L.W. Sage 684) and the taxon listed as Declared Rare Flora with a ranking of Endangered (Atkins 1999; Luu & English 2004). The ranking of the typical subspecies was simultaneously upgraded to Critically Endangered (Phillimore & Brown 2002) under the name *L. orbifolia* subsp. *orbifolia* ms (Western Australian Herbarium 1998–). There are currently five known natural populations and one translocation of subsp. Scott River Plains in the Augusta region and four natural populations and two translocations of subsp. *orbifolia* ms in the Narrikup region, with these regions being some 250 km apart. More recent genetic assessment using microsatellite markers has confirmed the genetic distinction of these disjunct regional groupings and supports their continued recognition as subspecies (Monks *et al.* 2021).

A formal taxonomic assessment of subsp. Scott River Plains has never been completed. Initially considered morphologically indistinguishable from the typical form (Hnatiuk 1995; Byrne *et al.* 1999), it was subsequently noted as having longer inflorescence bracts and flowers with a longer style (Phillimore & Brown 2002; Luu & English 2004), although comparative measurements were not documented. The recent discovery of two populations near Bowelling that cannot be confidently assigned to either subspecies brings a renewed sense of urgency to resolving this long-standing taxonomic issue. These new populations, which occur nearby to one another but some 100 km north of the species' previously known range, have been assigned the phrase name *L. orbifolia* subsp. Bowelling (A. Webb AW 09107) (Western Australian Herbarium 1998–).

Here we assess morphological variation across the informally recognised subspecies of *L. orbifolia* and add genetic data for subsp. Bowelling to the Monks *et al.* (2021) dataset, with a view to using both lines of evidence to resolve their taxonomic status and further inform the conservation and management of all subspecies.

Methods

Morphological and ecological data were obtained through the examination of specimens at the Western Australian Herbarium (PERTH), field observations and an assessment of available literature and images.

Leaf material for genetic analysis was collected from 24 widely spaced individuals from the population of subsp. Bowelling that was discovered in 2020 (the second population was found after these analyses were completed). Extraction of DNA and genotyping using microsatellite markers was undertaken following the methods outlined in Monks *et al.* (2021) except for the removal of two loci (Lo 22 and Lo 46) due to scoring inconsistencies. The resulting genotypic data was added to the data previously generated from the natural populations of subsp. *orbifolia* ms and subsp. Scott River Plains (Monks *et al.* 2021). No loci showed evidence of null alleles across all populations (Monks *et al.* 2021), therefore the combined dataset was considered suitable for re-analysis across the 11 microsatellite loci to assess genetic relationships among the three regional population groups using genetic diversity measures (allelic richness N_{AR} , observed heterozygosity H_O and expected heterozygosity H_E , and the inbreeding coefficient F_{IS}), differentiation measures (F_{ST} and D_{ST}), principal coordinates analysis (PCoA) and STRUCTURE analysis. Methodologies and running parameters for these analyses were identical to those used previously (see Monks *et al.* 2021), except that the hierarchical STRUCTURE analyses were run with a higher upper K value (in each case, the total number of populations plus one) to accommodate the possibility that the additional population may represent an additional cluster.

Population vouchers for the genetic study are as follows: subsp. *orbifolia* ms – ORB-J (PERTH

08599971), ORB-SS (PERTH 08575479), ORB-ES (PERTH 08575509), ORB-S (PERTH 08575487), ORB-WN (PERTH 05569508); subsp. Bowelling – BOW (PERTH 09279075); subsp. Scott River Plains – SRP-WD (PERTH 07464029); SRP-B (PERTH 04669126); SRP-D (PERTH 09444807); SRP-AS (PERTH 04135784).

Results and Discussion

The population of subsp. Bowelling showed similar levels of genetic diversity to populations of subsp. Scott River Plains and subsp. *orbifolia* ms (Table 1), with subsp. Scott River Plains showing higher values for N_{AR} , H_O , H_E and F_{IS} than subsp. *orbifolia* ms as per Monks *et al.* (2021). The population of subsp. Bowelling showed lower values for H_O and H_E and a higher value for F_{IS} than populations of the other two subspecies (Table 1), although none of these values were significantly different. Private alleles were found in nine loci for subsp. *orbifolia* ms, 10 loci for subsp. Scott River Plains and nine loci for subsp. Bowelling across the 11 microsatellite loci assessed.

There was significant genetic differentiation among the populations of *L. orbifolia*, with high overall values for genetic fixation and allelic differentiation ($F_{ST} = 0.395$; $D_{ST} = 0.587$) that were elevated from those in Monks *et al.* (2021) following the addition of the Bowelling population. Pairwise measures of F_{ST} among the subspecies were high (Table 2), with mean $F_{ST} = 0.294$ between populations of subsp. Scott River Plains and subsp. *orbifolia* ms, mean $F_{ST} = 0.261$ between subsp. Scott River Plains and subsp. Bowelling, and mean $F_{ST} = 0.351$ between subsp. *orbifolia* ms and subsp. Bowelling. Pairwise D_{ST} values showed the same relative patterns to the F_{ST} values, including higher differentiation in comparisons between regions than those within regions (Table 2).

The PCoA was consistent with Monks *et al.* (2021) in that the first axis (representing 35.4% of the total variation) separated individuals of subsp. Scott River Plains and subsp. *orbifolia* ms into two broad clusters and the second axis (18.7% of the variation) showed separation of the easternmost population of subsp. *orbifolia* ms (ORB-WN) from the remaining populations of that subspecies (Figure 1A). Individuals of subsp. Bowelling fell mid-way between the two clusters on the first axis (albeit with slightly closer affinity to subsp. Scott River Plains) but separated from both clusters on the second axis. The third axis explained a similar proportion of variation (17.72%) as the second axis and further separated the population of subsp. Bowelling from the subsp. Scott River Plains and subsp. *orbifolia* ms clusters, while the previously outlying ORB-WN population was more closely associated with the rest of the subsp. *orbifolia* ms cluster (Figure 1B).

STRUCTURE analysis results were largely consistent with that of Monks *et al.* (2021), identifying two major genetic groups to distinguish populations of subsp. *orbifolia* ms (Narrikup) from those of subsp. Scott River Plains (Augusta). The population of subsp. Bowelling grouped with the subsp. Scott River Plains cluster with no indication of admixture or ambiguity (Figure 2). Hierarchical analysis within each of these clusters detected further substructure. Within the subsp. *orbifolia* ms cluster, each population formed a separate subcluster as per Monks *et al.* (2021), while substructure within the subsp. Scott River Plains + subsp. Bowelling cluster clearly distinguished only the Bowelling population from the remaining populations. Further hierarchical assessment of the subsp. Scott River Plains subcluster identified the population structuring reported in Monks *et al.* (2021).

In addition to being genetically distinct, the three subspecies can be recognised morphologically using a combination of bract and indumentum features (detailed in the key below). Subsp. Scott River Plains can be diagnosed by its bracts, which have a glabrous or scarcely papillose outer surface (*cf.* densely hairy distally in the other two subspecies). The bracts are usually straight (the outermost

Table 1. Summary of sampling and mean (SE) genetic diversity measures for the three subspecies of *Lambertia orbifolia*. N_{POPS} = no. of populations sampled per region; N_{IND} = no. of individuals sampled per population; N_{AR} = allelic richness; H_{O} = observed heterozygosity; H_{E} = expected heterozygosity; F_{IS} = inbreeding coefficient.

Subspecies	N_{POPS}	N_{IND}	N_{AR}	H_{O}	H_{E}	F_{IS}
Scott River Plains	4	23.25 (0.28)	2.99 (0.34)	0.41 (0.03)	0.51 (0.05)	0.14 (0.03)
<i>orbifolia</i> ms	5	22.40 (0.94)	2.47 (0.24)	0.36 (0.06)	0.42 (0.07)	0.11 (0.06)
Bowelling	1	23.64 (0.36)	2.61 (0.30)	0.31(0.07)	0.39 (0.07)	0.29 (0.07)

Table 2. Pairwise F_{ST} (below diagonal) and D_{ST} (above diagonal) for populations of *Lambertia orbifolia* subsp. Scott River Plains (SRP), subsp. Bowelling (BOW) and subsp. *orbifolia* ms (ORB). Population vouchers are listed in the methods.

	SRP-WD	SRP-B	SRP-D	SRP-AS	BOW	ORB-J	ORB-SS	ORB-ES	ORB-S	ORB-WN
SRP-WD	-	0.018	0.270	0.244	0.614	0.735	0.771	0.512	0.684	0.687
SRP-B	0.020	-	0.231	0.164	0.615	0.721	0.779	0.538	0.693	0.717
SRP-D	0.129	0.117	-	0.285	0.510	0.783	0.843	0.649	0.845	0.676
SRP-AS	0.102	0.076	0.157	-	0.619	0.648	0.813	0.593	0.756	0.701
BOW	0.238	0.251	0.284	0.271	-	0.733	0.698	0.546	0.863	0.776
ORB-J	0.361	0.355	0.476	0.336	0.423	-	0.404	0.383	0.460	0.624
ORB-SS	0.228	0.232	0.337	0.263	0.281	0.227	-	0.316	0.449	0.501
ORB-ES	0.154	0.166	0.264	0.191	0.220	0.222	0.113	-	0.366	0.539
ORB-S	0.234	0.243	0.378	0.285	0.375	0.283	0.175	0.149	-	0.622
ORB-WN	0.308	0.328	0.407	0.323	0.454	0.415	0.276	0.273	0.363	-

ones are sometimes weakly recurved) rather than consistently strongly recurved like those of subsp. *orbifolia* ms; the bracts of subsp. Bowelling are somewhat variable in this regard but usually resemble the typical subspecies. While there is a strong tendency for subsp. Scott River Plains to have longer inner bracts than the typical subspecies, there is a degree of overlap (18–28 mm long *cf.* 12–20 mm in subsp. *orbifolia* ms), with bract length becoming less taxonomically reliable when populations of subsp. Bowelling are considered (15–23 mm long).

Subsp. Bowelling differs from the other two subspecies in having young branchlets with an even indumentum of short, crispate hairs (*cf.* with both long, spreading hairs and short, crispate hairs). It also has shorter hairs on the outer surface of the perianth (mostly to 0.2 mm long but sometimes with sparse hairs to 0.5(–1.5) mm long *cf.* hairs (0.5–)1–3 mm long in the other two subspecies). The flowers of the three subspecies are otherwise comparable, with colour varying both among and within populations. Style length, which is difficult to accurately measure on pressed material, does not appear to be taxonomically informative as previously suggested (Luu & English 2004).

The presence of private alleles, high levels of genetic differentiation and strong population structuring across populations of subsp. *orbifolia* ms, subsp. Scott River Plains, and subsp. Bowelling indicate significant restrictions to gene flow among these geographically disjunct subspecies. The addition of the subsp. Bowelling population to the genetic analysis did not alter the divergent patterns seen between subsp. *orbifolia* ms and subsp. Scott River Plains as per Monks *et al.* (2021), which were

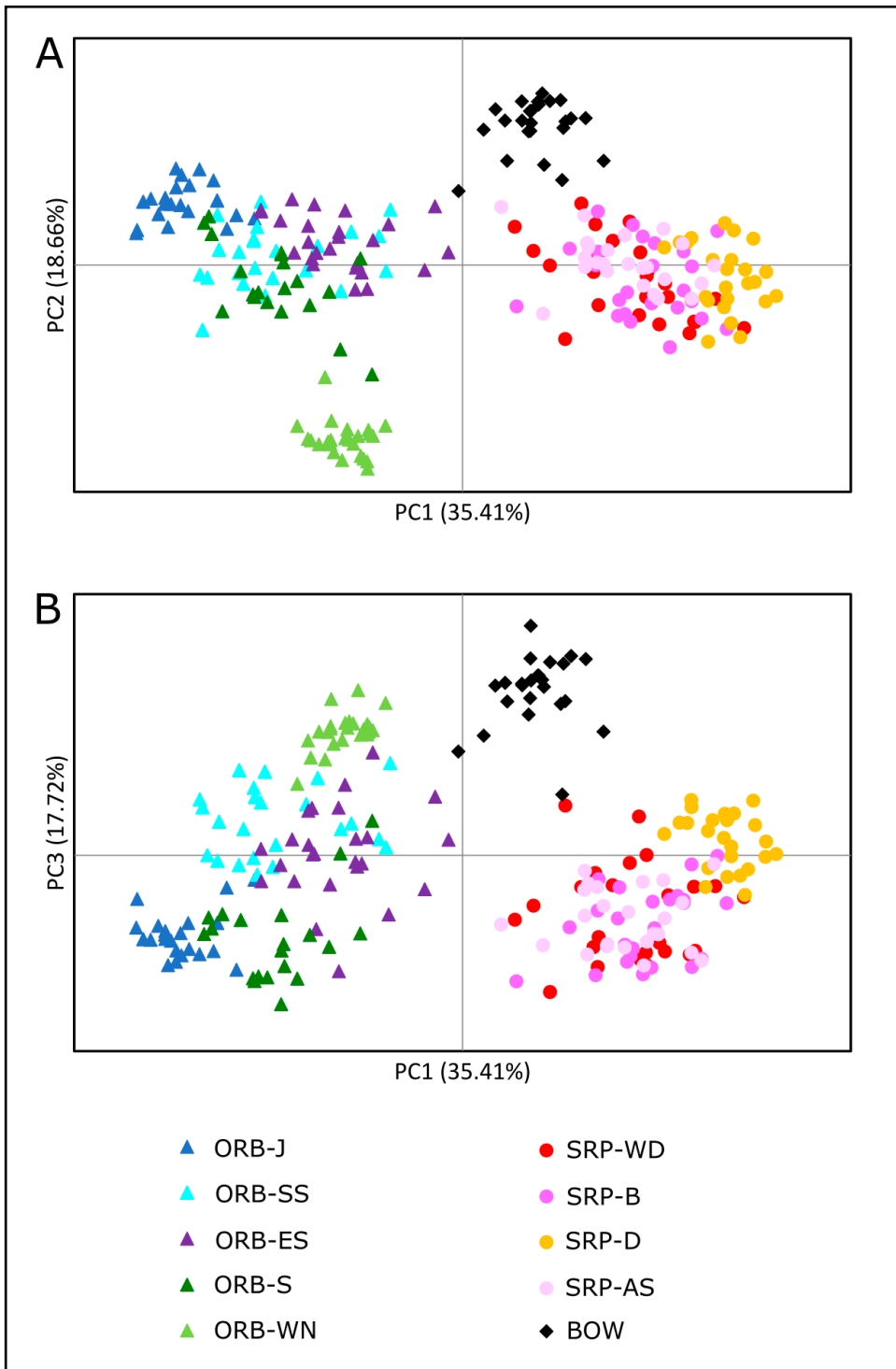


Figure 1. Principal coordinates analysis for individuals of *Lambertia orbifolia* sampled across 10 populations and three disjunct geographic regions: subsp. *orbifolia* ms (Narrikup) is represented by triangles, subsp. Scott River Plains (Augusta) by circles, and subsp. Bowelling by diamonds. A – principal coordinate (PC) axes 1 and 2; B – PC axes 1 and 3.

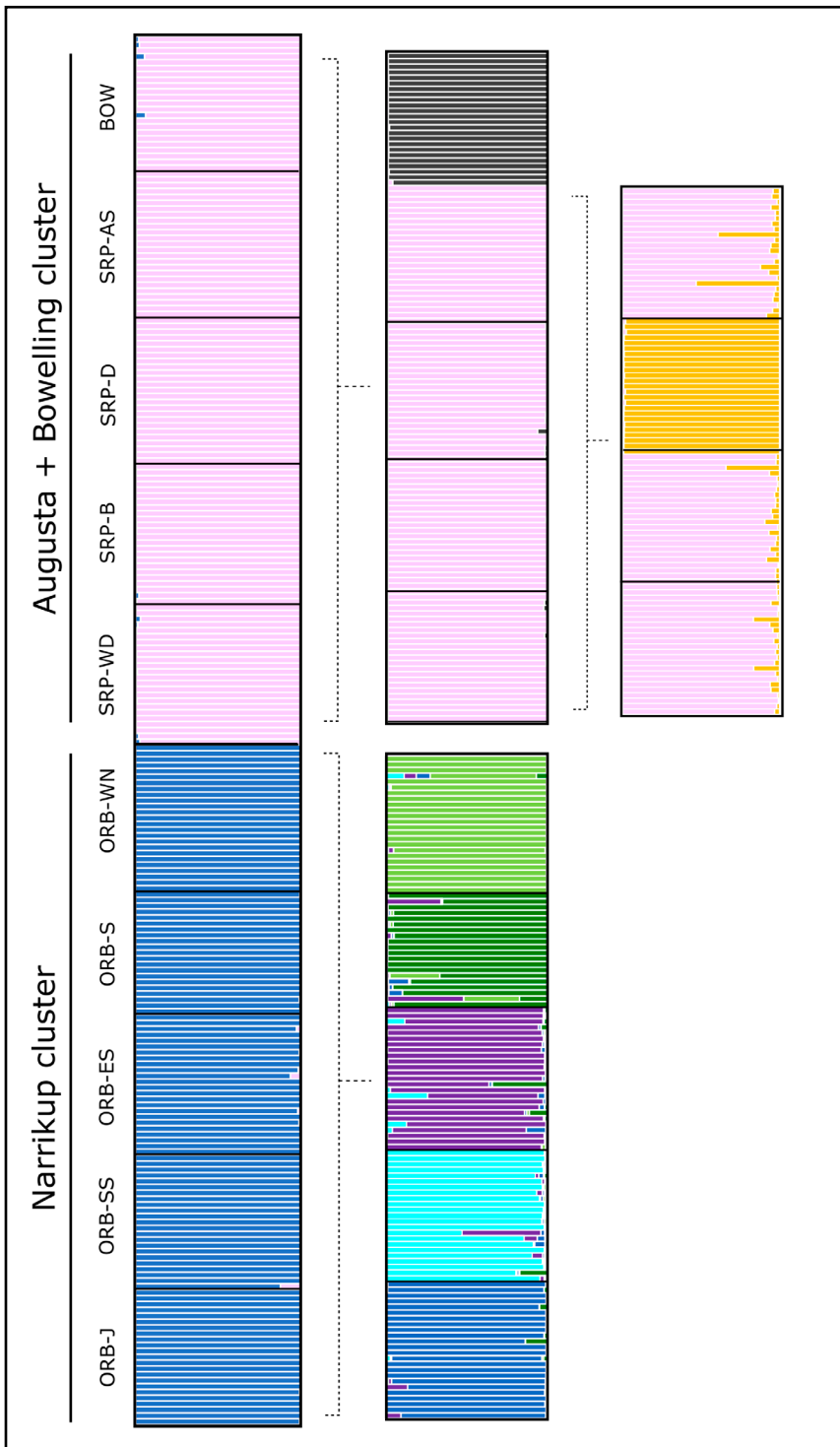


Figure 2. Upper tier – structure analysis for all sampled populations of *Lambertia orbifolia* showing two distinct genetic clusters ($K = 2$) comprising all populations of subsp. *orbifolia* ms (Narrikup cluster) and all populations of subsp. Scott River Plains and subsp. Bowelling (Augusta + Bowelling cluster). Middle tier – hierarchical analyses within the Narrikup ($K=5$) and Augusta + Bowelling ($K = 2$) clusters. Lower tier – further hierarchical analysis within the Augusta subcluster ($K = 2$).

also consistent with those found in older molecular studies (Byrne *et al.* 1999; Coates & Hamley 1999). While subsp. Bowelling shows a closer genetic affinity to subsp. Scott River Plains, its long-term geographic isolation is reflected in the hierarchical substructuring of this population as highly distinct from those of subsp. Scott River Plains. Coupled with morphological evidence, we consider these taxa to represent three independently functioning entities that warrant taxonomic recognition and individualised conservation management. A formal taxonomy is presented below.

Taxonomy

Lambertia orbifolia C.A.Gardner, *J. Roy. Soc. W. Australia* 47: 55 (1964). *Type*: Prope King River, King George's Sound, Western Australia, June 1962, *A.J. Gray s.n.* (*holo*: PERTH 01006576).

Single- or multi-stemmed *shrub* or *small tree* 2–6 m high, openly or densely branched, lignotuber apparently absent. *Branches* erect, spreading or arching, glabrescent; young branchlets usually with \pm spreading, rusty brown, simple hairs *c.* 0.5–3 mm long over dense, rusty brown or white crispate or sometimes antrorse hairs *c.* 0.1–0.3(–0.5) mm long, more rarely with the longer hairs absent. *Leaves* opposite, shortly petiolate, coriaceous, with dense, crispate hairs on adaxial surface towards base of adaxial midrib and on petiole, hairs sometimes present on remaining adaxial (rarely abaxial) veins or margins (especially when young); petiole 1.5–5 mm long; lamina orbicular, elliptic or ovate, 10–50 mm long, 8–40 mm wide, flat or somewhat cupped, with prominent reticulate venation, margins entire; apex rounded to obtuse or \pm subacute, sometimes apiculate; base cordate or rounded. *Conflorescence* terminal or on short, lateral shoots, 4–6-flowered. *Bracts* numerous, pale brown to dark red-brown, 1–25 mm long (inner bracts 10–25 mm long, outer bracts shorter), straight or with a weakly to strongly recurved tip; pubescent or tomentose on both surfaces and margins, densely so towards apex, becoming glabrous towards base, sometimes with hairs absent from abaxial (outer) surface (rarely completely glabrous). *Flowers* zygomorphic, facing outwards, suberect to spreading. *Perianth* red or orange-red with brownish or more rarely yellow limbs, *c.* 30–60 mm long, dilated about middle with limbs becoming tightly revolute, abaxial suture deepest; outer surface with simple, spreading, white or pale rusty brown hairs 0.2–3 mm long, sparse on tube, becoming denser distally; inner surface with scattered, thickened hairs *c.* 0.1–0.3 mm long. *Stamens* 4 (1 in each lobe of limb), shortly pedicellate, with an apical gland. *Ovary* densely brown- or white-pilose; style *c.* 3.5–5.5 mm long, glabrous distally, sparsely pilose towards base; stigma apically grooved, distal to slightly swollen pollen presenter. *Hypogynous glands* 4, free, glabrous. *Fruit* a follicle, splitting when seeds ripe, asymmetric, shortly beaked, 13–20 mm long, 5–11 mm diam., horns at distal end of suture scarcely developed or apparently absent; sides smooth, glabrescent. *Seeds* 1 or 2 per follicle, asymmetric in outline with one side \pm straight and the other rounded and very narrowly winged, 8–12 mm long, 4.8–6.2 mm wide; surface mottled, papillate. (Figures 3, 4)

Diagnostic features. Distinct from other species of *Lambertia* Sm. on account of its orbicular, elliptic or ovate leaves with a cordate or rounded base, entire margins and glabrous lower surface. One of three species in the genus with outward-facing flowers.

Phenology. Flowering (and presumably fruiting) throughout the year, with peak flowering in summer and early autumn.

Distribution and habitat. Endemic to the Jarrah Forest and Warren bioregions in south-western Australia where it is currently known from three, disjunct population centres near Narrikup, east of Augusta and south-west of Bowelling. Grows in sand or sandy clay over laterite on plains, gentle hillslopes and

low ridges, sometimes in seasonally wet areas, along riverbanks or adjacent to floodplains, in open woodland, tall shrubland over dense heath, and Proteaceous thickets.

Conservation status. Listed as Endangered under the federal *Environment Protection and Biodiversity Conservation Act 1999* (Department of Climate Change, Energy, the Environment and Water 2022). Threats to the species are disease caused by *Phytophthora cinnamomi* and aerial cankers (*Cryptodiaporthe* sp., *Diplodina* sp.), climate change, inappropriate fire regimes, grazing by feral and native herbivores, road, track and firebreak maintenance, weed invasion and salinity (Luu & English 2004; Phillimore & Brown 2002).

Notes. *Lambertia orbifolia* shares outward-facing flowers with *L. inermis* R.Br. and *L. ericifolia* R.Br., both of which have narrower leaves with revolute margins and a dense indumentum on the undersurface. It is a non-serotinous, obligate seeder (Sage & Lamont 1994). Three subspecies are recognised.

- 1 Bracts strongly recurved, densely hairy distally on both surfaces; inner bracts 12–20 mm long. Outer surface of perianth tube with hairs (0.5–)1–3 mm long. Young branchlet indumentum of long, ± spreading hairs over dense crispate hairs [Narrikup] subsp. **orbifolia**
1. Bracts usually erect, the outer ones sometimes weakly recurved, outer surface glabrous or scarcely papillose, inner surface densely to sparsely hairy distally (rarely glabrous); inner bracts 18–28 mm long. Outer surface of perianth tube with hairs (0.5–)1–3 mm long. Young branchlet indumentum usually of long, ± spreading hairs over dense crispate hairs, rarely with longer hairs absent [Scott River Plain] subsp. **vespera**
- 1: Bracts erect or weakly to strongly recurved, densely hairy distally on both surfaces; inner bracts 15–23 mm long. Outer surface of perianth tube with inconspicuous hairs mostly to 0.2 mm long, sometimes with sparse hairs to 0.5(–1.5) mm long. Young branchlet indumentum of short, ± even, crispate hairs [SW Bowelling] subsp. **pecuniosa**

Lambertia orbifolia C.A.Gardner **subsp. orbifolia**

Lambertia orbifolia C.A.Gardner subsp. *orbifolia* ms, Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 10 November 2022].

Illustrations. A.S. George, *An introduction to the Proteaceae of Western Australia* 88, Plate 131 (1984); R.M. Sainsbury, *A field guide to smokebushes and honeysuckles (Conospermum and Lambertia)* 87 (1991); R.J. Hnatiuk, *Flora of Australia* 16: 434, Figure 185B–E (1995).

Shrub 2–3.5 m high. *Young branchlets* with a mixed indumentum of ± spreading hairs over a dense layer of shorter, crispate hairs. *Leaf lamina* 9–35 mm long, 9–30 mm wide, base cordate or rounded. *Bracts* strongly recurved, tomentose to pubescent on both surfaces and margins, hairs very dense distally, becoming glabrous towards base; inner bracts 12–20 mm long. *Perianth* red or orange-red with brownish or yellowish brown limbs; outer surface of tube with hairs (0.5–)1–3 mm long. (Figure 3A)

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 30 Nov. 1999, *S. Barrett* 816 (PERTH); 23 Apr. 2013, *S. Barrett* 2151 (MEL *n.v.*, PERTH); 26 Feb. 2014, *J.A. Cochrane, S. Barrett & E. Harper* JAC 8313 (PERTH); 6 May 1964, *A.S. George* 6217 (PERTH); 25 Jan. 1995, *B.G. Hammersley* 1329 (PERTH); 9 Aug. 1980, *N.G. Marchant* 80/70 (CANB *n.v.*, PERTH); 22 Jan. 1964, *K.R. Newbey* 1231 (PERTH); 29 Jan. 2003, *A. Spooner* SEAS 12 C (PERTH).

Flowering period. Flowering throughout the year. Sage and Lamont (1994) noted peak flowering occurred in January and February, and from May to July.

Distribution and habitat. Restricted to the Narrikup area in the Southern Jarrah Forest; the type population from the King River is apparently no longer extant. Grows in sand over laterite on plains, gentle hillslopes and low ridges in *Eucalyptus marginata*, *Corymbia calophylla* and *Banksia grandis* woodland with associated species such as *Nuytsia floribunda*, *Agonis theiformis*, *Taxandria parviceps*, *Hakea ferruginea* and *Leucopogon verticillatus*.

Conservation status. Listed as Threatened (Critically Endangered) in Western Australia (State of Western Australia 2022), as *L. orbifolia* subsp. *orbifolia* ms.

Vernacular name. Round-leaf Honeysuckle.

Lambertia orbifolia* subsp. *vespera A.D.Webb, L.T.Monks & Wege, *subsp. nov.*

Type: Scott River Plain, north-east of Augusta, Western Australia [precise locality withheld for conservation reasons], 20 December 2021, J.A. Wege & B.P. Miller JAW 2193 (*holo:* PERTH 09444807 [sheet 1 of 2], PERTH 09444815 [sheet 2 of 2]; *iso:* NSW).

Lambertia orbifolia subsp. Scott River Plains (L.W. Sage 684), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 10 November 2022].

Shrub or small tree 2–5 m high. *Young branchlets* usually with a mixed indumentum of \pm spreading hairs over a dense layer of shorter, crispate hairs, rarely with the longer hairs apparently absent. *Leaf lamina* 10–50 mm long, 10–40 mm wide, base cordate or rounded. *Bracts* usually straight or sometimes with the outmost ones weakly recurved, sparsely hairy on margins, outer surface glabrous or scarcely papillose, inner surface densely to very sparsely pubescent distally (rarely completely glabrous); inner bracts 18–28 mm long. *Perianth* red or orange-red with brownish limbs; outer surface of tube with hairs (0.5–)1–3 mm long. (Figure 3B–D)

Selected specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 18 Jan. 1996, J.A. Cochrane JAC 1909 (PERTH); 18 Feb. 1997, J.A. Cochrane JAC 2339 (PERTH); 16 Jan. 2007, J.A. Cochrane, S. Gale, M. Spencer & J. Liddelow JAC 6325 (PERTH); 11 Oct. 1991, C.J. Robinson 782 (PERTH); 17 Jan. 1945, R.D. Royce 67 (PERTH); 28 Sep. 1994, L.W. Sage 684 (PERTH); 20 Nov. 1996, A. Webb AW 023 (PERTH).

Flowering period. Flowers have been recorded from September to May, with peak flowering in January and February (Sage & Lamont 1994).

Distribution and habitat. Known only from the Scott River plain, east of Augusta and mostly in the Warren bioregion, where it is restricted to the ‘Scott River Ironstone Association’ threatened ecological community (Luu & English 2004); a collection made in 1969 from Busselton (PERTH 01040766) is either a locality error or the population is no longer extant. Grows in sand or sandy clay in association with ironstone, around seasonally wet areas near the coast or further inland on riverbanks or more upland plains. Associated vegetation is open woodland of *Eucalyptus marginata*, *Corymbia calophylla* or *Agonis flexuosa* over closed shrubland, or shrubland over dense heath. It can form thickets in association with *Banksia littoralis*, *B. ilicifolia*, *B. grandis* and *Hakea prostrata*, and is often recorded



Figure 3. *Lambertia orbifolia*. A – subsp. *orbifolia*, showing the outwards-facing flowers characteristic of the species, long hairs on the perianth tube (also characteristic of subsp. *vespera*), and strongly recurved bracts; B – young stem portion of subsp. *vespera* showing the long hairs that occur with much shorter, crispate hairs (also characteristic of subsp. *orbifolia*); C – habit of subsp. *vespera*; D – inflorescence of subsp. *vespera* showing the long, straight, inner bracts that have a glabrous or scarcely papillose outer surface. Photographs by J.A. Wege from a mature plant at the Western Australian Botanic Garden (Kings Park) that was grown from seed sourced from the Narrikup area (A), J.A. Wege from PERTH 09444815 (B, D), and L. Monks from PERTH 07464029 (C).

growing with *Calothamnus lateralis* var. *crassus* and *Kunzea recurva*, or with *Taxandria juniperina* in riparian habitats.

Conservation status. Listed as Threatened (Endangered) in Western Australia (State of Western Australia 2022), as *L. orbifolia* subsp. Scott River Plains (L.W. Sage 684).

Etymology. From the Latin *vesperus* (of the evening, western), a reference to its distribution.

Vernacular name. Scott River Honeysuckle.

Lambertia orbifolia* subsp. *pecuniosa A.D. Webb, L.T. Monks & Wege, *subsp. nov.*

Type: south-west of Bowelling, Western Australia [precise locality withheld for conservation reasons], 8 February 2022, J.A. Wege, L. Monks, A. Webb & T. Cartagena JAW 2195 (*holo:* PERTH 09444823; *iso:* MEL, NSW).

Lambertia orbifolia subsp. Bowelling (A. Webb AW 09107), Western Australian Herbarium, in *Florabase*, <https://florabase.dpaw.wa.gov.au/> [accessed 10 November 2022].

Shrub or small tree 2.5–6 m high. Young branchlets with a short, dense indumentum of crisped or more rarely antrorse hairs mostly to *c.* 0.2 mm long (to 0.3 mm long near leaf insertion). *Leaf lamina* 8–30 mm long, 7–28 mm wide, base rounded (rarely cordate). *Bracts* erect or more often weakly to strongly recurved, tomentose to pubescent on both surfaces and margins with the hairs very dense distally, becoming glabrous towards base; inner bracts 15–23 mm long. *Perianth* red with yellow or brownish limbs; outer surface of tube inconspicuously hairy, the hairs mostly to 0.2 mm long, with very sparse hairs to 0.5(–1.5) mm long. (Figure 4)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 21 Feb. 2020, A. Webb AW 09107 (AD, PERTH); 5 Mar. 2021, A. Webb AW 09127 (PERTH); 13 Jan. 2022, A. Webb AW 09129 (CANB, MEL, NSW, PERTH); 8 Feb. 2022, J.A. Wege, L. Monks, A. Webb & T. Cartagena JAW 2196 (PERTH).

Flowering period. Flowering has been recorded from January to March.

Distribution and habitat. Currently known from two population centres associated with a tributary of the east branch of the Collie River, south-west of Bowelling in the Southern Jarrah Forest. At the type locality it grows in sand overlying clay at depth in the ecotone between floodplain and dryland vegetation, in open *Eucalyptus wandoo* and *E. rudis* woodland with *Banksia attenuata*, *B. littoralis*, *Melaleuca preissiana* and *Nuytsia floribunda*. At the second locality it occurs on lower hillslopes in loamy sand or sand over laterite (probably with clay at depth), in *Eucalyptus marginata* and *Banksia attenuata* woodland, and is dominant in the middle-storey alongside *B. sessilis*.

Conservation status. Listed as Priority Two under Conservation Codes for Western Australian flora (Western Australian Herbarium 1998–), as *L. orbifolia* subsp. Bowelling (A. Webb AW 09107). Recent targeted surveys suggest that this taxon is highly localised and is likely to warrant listing as Threatened. There are two populations, one of which occurs in a Conservation Park, and threats include mining, feral pig activity, and *Phytophthora* dieback disease.

Etymology. The epithet is from the Latin *pecuniosus* (moneyed, rich, wealthy) and is a reference to the penny-like leaves. Local property owners have long been aware of this taxon, referring to it as ‘Penny Bush’.

Vernacular name. Penny-leaved Honeysuckle.

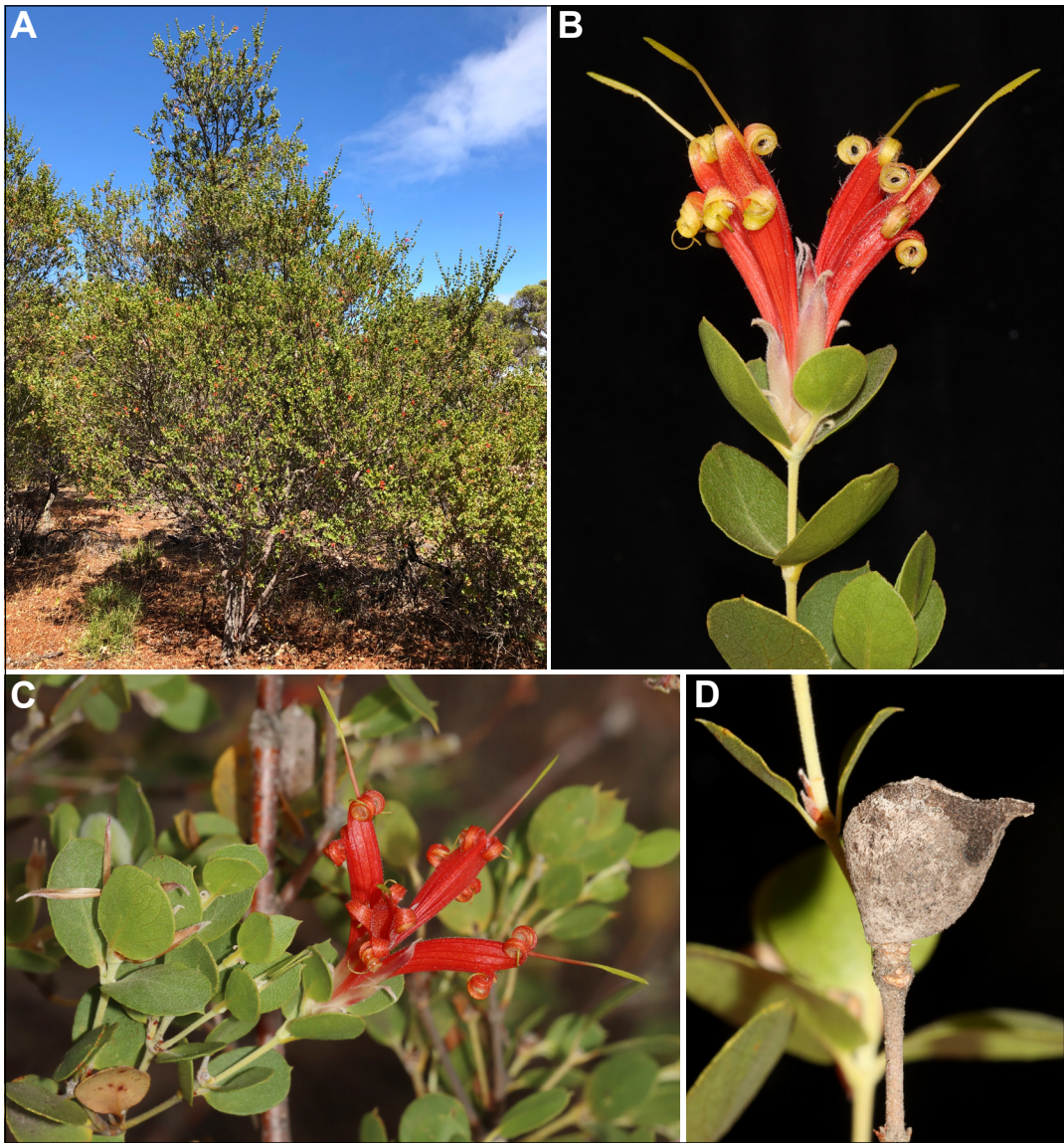


Figure 4. *Lambertia orbifolia* subsp. *pecuniosa*. A – habit; B – flowering branchlet showing the hairy bracts with a weakly to strongly recurved tip and yellow perianth limbs. Note the young stem has consistently short (rather than both long and short) hairs, and the hairs on the perianth tube are mostly very short; C – flowering branchlet showing reddish perianth limbs; D – fruit. Photographs by J.A. Wege from PERTH 09444823 (A, B, D) and PERTH 09444831 (C).

Acknowledgements

We thank staff at the Western Australian Herbarium for curatorial support, Tayla Cartagena for field assistance and survey effort, Amanda Shade for onsite support at Kings Park, and Kelly Shepherd and an anonymous reviewer for their time and comments.

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