Volume 16: 19–41
Publication date: 9 April 2014
dx.doi.org/10.7751/telopea20147400

TELOPEA
Journal of Plant Systematics

The Royal Botanic Gardens & Domain Trust

plantnet.rbgsyd.nsw.gov.au/Telopea • escholarship.usyd.edu.au/journals/index.php/TEL • ISSN 0312-9764 (Print) • ISSN 2200-4025 (Online)

Leptocarpus (Restionaceae) enlarged to include *Meeboldina* and *Stenotalis*, with new subgenera and Western Australian species

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Abstract

A recent phylogeny of the restiid clade of Poales based on DNA data from the chloroplast genome indicates that several currently recognised genera of Leptocarpoideae are paraphyletic or polyphyletic. Morphology and DNA data both indicate that the species included in *Meeboldina* consist of two groups. Moreover, *Leptocarpus* and the monotypic *Stenotalis* both appear embedded in *Meeboldina*, as the latter has been recognised in recent classifications. Consequently, *Leptocarpus* is here enlarged to encompass *Meeboldina* and *Stenotalis* and new subgenera *Leptocarpus*, *Meeboldina* and *Stenotalis* are recognised. The new combination *Leptocarpus denmarkicus* (Suess.) B.G.Briggs [previously *Meeboldina denmarkica* Suess.] is provided and the new epithet and combination *Leptocarpus scoparius* B.G.Briggs [previously *Stenotalis ramosissima* (Gilg) B.G.Briggs & L.A.S.Johnson, basionym *Hypolaena ramosissima* Gilg, non *Leptocarpus ramosissimus* Pillans]. Eight new species from the south of Western Australia are described: *L. crebriculmis*, *L. decipiens*, *L. depilatus*, *L. elegans*, *L. kraussii*, *L. roycei*, *L. tephrinus* and *L. thysananthus*.

Introduction

In classifying the non-African Restionaceae, Briggs and Johnson (1998a, 1998b, 1999) described a number of new genera to accommodate distinctive groups. That classification has also been largely used for the Australian members by Meney and Pate (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002) and adopted in a treatment of the family (Linder et al. 1998). When that classification was proposed very few DNA sequences were available, although DNA-based phylogenies were later presented by Briggs et al. (2000, 2010). A more comprehensively sampled phylogeny of the Leptocarpoideae, based on *trn*L–F and *trn*K data from the chloroplast genome is now available (Briggs et al. 2014) and the part of the phylogenetic tree relevant to *Leptocarpus* is shown in Figure 1.

I acknowledge that the available molecular data are derived only from the plastid genome, not all species have been sequenced, and some have been sequenced for only a single region. Nevertheless, it appears preferable to provide a classification in better agreement with the available phylogeny and to incorporate this into an account of the Australian taxa to be prepared for *Flora of Australia*. In addition to enlarging *Leptocarpus*, changes are necessary in the *Desmocladus* clade (Briggs 2014), reducing further small genera to synonymy.

The genus *Leptocarpus*

The circumscription of *Leptocarpus* R.Br. (Brown 1810), type genus of subfamily Leptocarpoideae (Briggs and Linder 2009), has varied greatly since its original publication. Originally a genus of seven species, *Leptocarpus* was enlarged to include numerous South African species (Masters 1869, Pillans 1928), before being restricted – largely on the basis of culm anatomy – to non-African members (Gilg 1890, Gilg-Benedict 1930, Johnson and Briggs 1981, Linder 1985). Cutler (1969) included both African and Australasian species under *Leptocarpus* but made clear that these formed distinct geographical and anatomical groups. The recognition of *Meeboldina* Suess. and description of new genera *Apodasmia*, *Dapsilanthus* and *Stenotalis* by Briggs and Johnson (1998a, 1999) reduced *Leptocarpus* to two described species, together with one that is described below. In recognising these segregate genera, they paid particular attention to the structure of the spikelets and the presence or absence of bracts on the female floral axis distal to the glume that suggest differences in the degree of condensation and reduction in the inflorescence. Such bracts also indicate that the spikelets are compound structures. Where there are two such bracts, these are unequal.

The phylogeny of Leptocarpoideae presented by Briggs et al. (2014) was based on concatenated sequences of *trn*K and *trn*L–F with coded indels, analysed by both Bayesian inference and maximum parsimony. Most species are represented by a single sequence for each gene but several are replicated. A majority rule consensus cladogram from Bayesian inference (Fig. 1) shows robust support for the *Leptocarpus* clade, for *Alexgeorgea*, *Hypolaena*, *Leptocarpus* as here enlarged, and the groups indicated by 'M' and 'L'. The inclusion of *Meeboldina coangustata* in the 'S' group receives less support. Only one of the four species of *Dapsilanthus* has been sequenced, so the monophyly of this genus has not been tested. *Apodasmia* is strongly supported as monophyletic but its relationship to *Chaetanthus* is not resolved.

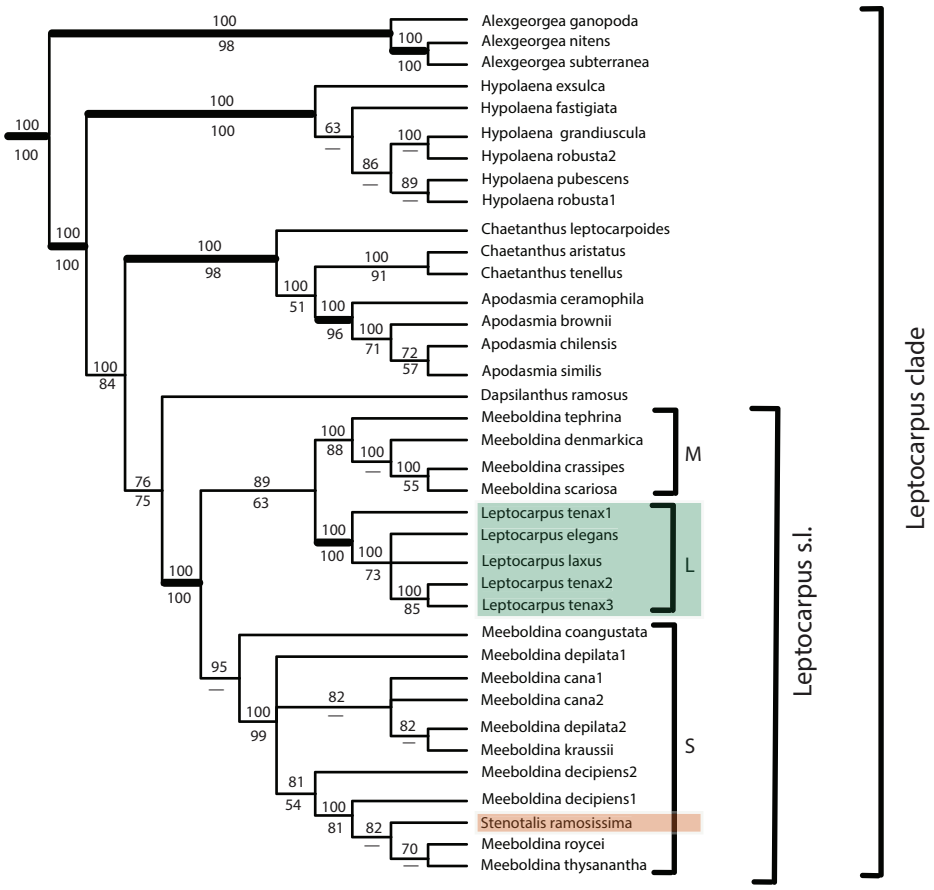

Fig. 1. Phylogenetic tree of *Leptocarpus* clade: a majority rule consensus cladogram from Bayesian analysis of concatenated *trn*L–F and *trn*K chloroplast sequences with coded indels (modified from Briggs et al. 2014). *Leptocarpus* s.str. and *Stenotalis* are shown embedded in *Meeboldina.* The subgenera are indicated by 'L', 'M' and 'S' respectively. Bayesian posterior probabilities are shown above the branches; bootstrap values from maximum parsimony PAUP* analyses of the same data below the branches. Thick lines have 100% Bayesian posterior probability and also >95% parsimony support. Branches not present in the PAUP tree are indicated by a dash below the line. Species named here are shown by the informal manuscript names under *Leptocarpus* or *Meeboldina* by which they have recently been known. For a few species, including *M. crassipes*, only *trn*L–F data were available and dummy sequences (NNN….) were used in the *trn*K alignment.

Alexgeorgea and *Hypolaena,* the first divergent lineages of the clade, both have one or two bracts on the female flower stalk. The next branch, *Chaetanthus* with *Apodasmia*, lacks such bracts. Bracts are present in *Dapsilanthus* and two subgenera (see below) of *Leptocarpus s. lat.*, but not in subgenus *Leptocarpus*. It appears that bracts have been separately lost in the *Chaetanthus* branch and in subgenus *Leptocarpus*, but alternative possibilities involving different extents of inflorescence elaboration, condensation and reduction should also be considered.

The phylogeny presented by Briggs et al. (2014) also shows that the species previously classified as *Leptocarpus* and *Stenotalis* are embedded within *Meeboldina* and that the species referred to *Meeboldina* form two clades (Fig. 1). These two clades, together with *Leptocarpus s. str.*, are here recognised as subgenera and their diagnostic features and members are indicated below. *Stenotalis* was distinguished from *Leptocarpus* and *Meeboldina* on the basis of its much-branched habit, with many slender short lateral branches, and its very slender 1- or 2-flowered female spikelets. These features appear to be autapomorphies that are no obstacle to inclusion in *Meeboldina* or in a more inclusive *Leptocarpus*.

Leptocarpus, enlarged by the synonymisation of *Meeboldina* and *Stenotalis* as well as the description here of eight new species, includes 15 or 16 species. It may be distinguished from related genera as in the following key.

Key to genera of the *Leptocarpus* clade

1 Rhizome and culm bases sheathed by highly glossy scales; rhizomes long and slender; anthers exserted; male spikelets erect; female flowers borne on short branches from the rhizomes, subterranean except for style, stigmatic branches and surrounding bracts that emerge above ground level ..... *Alexgeorgea*

1* Rhizome and culm bases sheathed by dull or slightly glossy scales; rhizomes long or short or plant caespitose; anthers enclosed or exserted; male spikelets erect or pendulous; female flowers borne on aerial branches 2

2 Pericarp of nut woody; female spikelets 1-flowered; culms mostly branched below the inflorescence .... *Hypolaena*

2* Pericarp of nut papery; female spikelets with 1– many flowers; culms unbranched or branched below the inflorescence 3

3 Female flowers in spikelets of 1– many flowers, but often several spikelets crowded on short final branches in axils of small spathes closely spaced along extended inflorescence branches; male and female inflorescences very different in appearance; male spikelets mostly pendulous ..... *Leptocarpus*

3* Female flowers not in distinct spikelets; fascicles of 3–5 flowers and glumes crowded into larger aggregations surrounded by ovate-lanceolate spathes or in small clusters borne along elongated inflorescence branches; male and female inflorescences very different or similar; male spikelets pendulous or erect 4

4 Female flower clusters numerous and small on elongated inflorescence branches; male flowers without a swollen base; culms branched or unbranched ..... *Dapsilanthus*

4* Female flower clusters sessile on the culm or on very short branches; male flowers mostly with a globular swollen base (except *C. leptocarpoides*); culms unbranched below the inflorescence 5

5 Caespitose; fruiting perianth of slender aristate tepals 2–8 times as long as fruit; anthers not exserted ..... *Chaetanthus*

5* Rhizomatous; fruiting perianth of ovate to lanceolate tepals less than twice as long as fruit; anthers fully or partly exserted ..... *Apodasmia*

Names of *Leptocarpus* species

Four of the species known in recent decades by names in *Meeboldina* were originally described as species of *Leptocarpus.* Seven others have been known by informal epithets and are described below. The following names are available (with the names by which they have recently been known where these are different).

Leptocarpus canus Nees, *Ann. Mag. Nat. Hist.* 6: 50 (1841).

Synonym: *Meeboldina cana* (Nees) B.G.Briggs & L.A.S.Johnson

Leptocarpus coangustatus Nees in Lehm., *Pl. Preiss.* 2: 65 (1846).

Synonym: *Meeboldina coangustata* (Nees) B.G.Briggs & L.A.S.Johnson

Leptocarpus crassipes J.S.Pate & K.A.Meney, *Telopea* 6: 658 (1996).

Synonym: *Meeboldina crassipes* (J.S.Pate & K.A.Meney) B.G.Briggs & L.A.S.Johnson

Note: My field observations of this taxon suggest that *L. crassipes* is not separable from *L. scariosus*, but rather was based on an unusual or aberrant variant or a condition associated with prolonged inundation of the plant base. Pate and Meney (1996) note its close affinity to *L. scariosus* but distinguish *L. crassipes* by bulbous culm bases, 'bulb-like swellings of the rhizome at points of attachment of culm bases' and unusually sparse inflorescences. Collections by J.S. Pate and K.A. Meney from the type location, Kent River between Denmark and Walpole (*Pate and Meney KM 913*), and by A.S. George from a small but deep waterhole 7 km south of Northcliffe (*George 8671,* 10 March 1967), show these features. Collections and observations at other times in the Kent River district, the Northcliffe site, and more widely over the range of *L. scariosus* did not show populations of plants with the features described for *L. crassipes*. Slight thickening of the culm base is, however, common in *L. scariosus*. *Leptocarpus crassipes* is described in the protologue (Pate and Meney 1996). as growing in permanently inundated habitats. *Leptocarpus scariosus* mostly grows in seasonally wet habitats that are summer dry; it may react to more prolonged inundation by developing thickened aerenchymatous culm bases. Sparse inflorescences may also be associated with growth under unusual, non-optimal conditions. In the analyses of DNA data (Fig.1), which are based on *trn*L–F alone (*trn*K lacking) for *L. crassipes*, these are grouped, but with low bootstrap support in maximum parsimony analyses. Their *trn*L–F sequences differ in several small indels and base changes but are similar in several features not shared with the sequences of allied species. These data are not conclusive since similar differences were found between replicate samples of related species with long branches in the tree for this highly variable gene region. More sampling and field observations are necessary to determine the status of *L. crassipes*.

Leptocarpus laxus (R.Br.) B.G.Briggs, *Taxon* 50: 891 (2001).

Leptocarpus scariosus R.Br., *Prodr.*: 250 (1810).
Synonym: *Meeboldina scariosa* (R.Br.) B.G.Briggs & L.A.S.Johnson

Leptocarpus tenax (Labill.) R.Br., *Prodr.*: 250 (1810).
Conserved type of *Leptocarpus* (see Briggs 2001, 2005; Briggs and Linder 2009, p. 339).

The following new combination is provided.

Leptocarpus denmarkicus (Suess.) B.G.Briggs, **comb. nov.**

Basionym: *Meeboldina denmarkica* Suess., Boissiera 7: 21 (1943). Type of *Meeboldina* Suess.

Note: The species was described by Suessenguth (1943) as monoecious but all isotypes show separate male and female plants closely intertwined. The photograph in the protologue of the holotype (Western Australia: Denmark, *Meebold 1389*, Nov 1928 ♂, ♀ [holo M n.v.; iso B!, BRI!, K!, MEL!, PERTH!]) is unclear but consistent with such a dioecious condition.

In addition, the following new epithet and combination is provided.

Leptocarpus scoparius B.G.Briggs, **nom. nov.**

Synonym: *Hypolaena ramosissima* Gilg, *Bot. Jahrb. Syst.* 35: 89 (1904).

Synonym: *Stenotalis ramosissima* (Gilg) B.G.Briggs & L.A.S.Johnson, *Telopea* 7: 369 (1998) (Type and only species of *Stenotalis* B.G.Briggs & L.A.S.Johnson), non *Leptocarpus ramosissimus* Pillans, *Trans. Roy. Soc. S. Africa* 30: 262 (1945).

Etymology: from *scoparius* (Latin) = a broom, referring to the habit with abundant fine branches. Because of possible confusion of names with *Dapsilanthus ramosus* (R.Br.) B.G.Briggs & L.A.S.Johnson (previously *Leptocarpus ramosus* R.Br.) in northern Australia, Aru Islands and New Guinea., an epithet with a different derivation has been chosen.

New subgenera of *Leptocarpus*

Leptocarpus R.Br. **subgenus *Leptocarpus***

Type: *Leptocarpus tenax* R.Br., the conserved type of *Leptocarpus.*

This autonymic subgenus arises with the recognition of other subgenera of *Leptocarpus*.

Diagnosis: culms not or sparsely branched below the inflorescence; female spikelets terminal on culms and

short distal inflorescence branches; female glumes leathery and rigid, longer than the flowers; female flowers dorsiventrally flattened with winged lateral outer tepals; bracts absent between glume and female flower; fruits dispersed with attached tepals.

Species included: *L. elegans* B.G.Briggs (described below), *L. laxus* and *L. tenax*.

Leptocarpus* subgenus *Meeboldina (Suess.) B.G.Briggs, **comb. and stat. nov.** Basionym: *Meeboldina* Suess., *Boissiera* 7: 20 (1943).

Type: *Leptocarpus denmarkicus* (Suess.) B.G.Briggs *Telopea* 16: 22 (2014, see above).

Diagnosis: culms not branched below the inflorescence; female spikelets terminal on culms or on short distal inflorescence branches; female glumes thin-textured and scarious, more than twice as long as the tepals, female flowers cylindrical or dorsiventrally flattened; outer tepals of female flowers linear or spathulate but not winged; two bracts (or rarely only one) present between glume and female flower, bracts unequal, sometimes one long and awn-like; fruits dispersed with tepals and bracts attached.

Species included: *L. crassipes* (if distinct from *L. scariosus* – refer discussion above), *L. denmarkicus, L. scariosus*, and *L. tephrinus* B.G.Briggs (described below).

Leptocarpus* subgenus *Stenotalis (B.G.Briggs & L.A.S.Johnson) B.G.Briggs, **comb. and stat. nov.**

Basionym: *Stenotalis* B.G.Briggs & L.A.S.Johnson. *Telopea* 7: 368 (1998).

Type: *Leptocarpus scoparius* B.G.Briggs. *Telopea* 16: 22 (2014, see above).

Diagnosis: culms branched or unbranched; male and female spikelets singly or in small clusters along inflorescence branches or upper part of culm; female glumes about as long as the flowers, female flowers not dorsiventrally flattened and outer tepals not winged; 2 bracts present between glume and female flower; fruits dispersed with tepals and bracts attached.

Species included: *L. canus, L. coangustatus, L. scoparius* and the following new species (described below): *L. crebriculmis*, *L. decipiens*, *L. depilatus*, *L. kraussii*, *L. roycei* and *L. thysananthus.*

Key to subgenera of *Leptocarpus*

1 Lateral tepals of female flowers with broad apical wings; female spikelets without bracts between the flower and subtending glume; female flowers dorsiventrally flattened; fruits dispersed with attached tepals; female glumes more than twice as long as the tepals ..... subgenus *Leptocarpus*

1* Lateral tepals of female flowers not winged; female flowers two bracts (rarely only one) between the flower and subtending glume, one bract sometimes long and awn-like; female flowers mostly not dorsiventrally flattened; fruits dispersed with attached tepals and bracts; female glumes equalling or longer than tepals 2

2 Female glumes hyaline or scarious, more than twice as long as tepals; culms unbranched below the inflorescence ..... subgenus *Meeboldina*

2* Female glumes thicker textured, less than twice as long as tepals; culms branched or unbranched .... subgenus *Stenotalis*

Description of new species

Seven of the new species described below have been known recently by manuscript names under *Meeboldina* and one referred to the genus *Leptocarpus* (Briggs and Johnson 1999, Meney and Pate 1999, Meney et al. 1999, Paczkowska and Chapman 2000, Wheeler et al. 2002). The late L.A.S. Johnson made important contributions to distinguishing many of them, but further field and herbarium studies have clarified their features and distributions. In addition, the generic classification is here changed to take account of the findings from DNA data. Since there has been a change in generic assignment for most of them, as well as altered circumscription and rank for some of the taxa, I am publishing them under sole authorship.

Branch lengths are particularly long in *Leptocarpus* in DNA-based phylograms but many branches shown in Figure 1 collapse or are poorly supported in parsimony analyses. Where multiple samples of a species (as identified morphologically) are included these are not always retrieved as monophyletic. *Leptocarpus tenax* 1 from Tasmania is not sister to *L. tenax* 2 and 3 from Western Australia. Also, the two samples of *L. depilatus* are separated, despite being from the same collection site. More extensive sampling and DNA sequencing is desirable to study the variation within and between species.

Now that the distinctive features of the species and their distributions are better known, some past specimen identifications need correction, resulting in more clearly defined distribution ranges than earlier identifications would indicate. Distribution maps have been prepared from specimen records in the *Atlas of Living Australia* website (ALA 2014), with checking and removal of records that may be based on misidentifications. Comments on regeneration after fire are largely from my observations, which are in agreement with those of Meney et al. (1999). Chromosome number records are from Briggs (2012). Specimens are generally cited in north to south sequence, except where a west to east arrangement is more informative. The IBRA bioregions (IBRA 2012) are used to summarise species distributions. In lists of specimens, the originating herbarium precedes those holding duplicate specimens.

Leptocarpus elegans B.G.Briggs, **sp. nov.**

'*Leptocarpus elegans* B.G.Briggs & L.A.S.Johnson, unpubl.', Briggs & Johnson (1999); Meney et al. (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002); *Leptocarpus* sp. A, Briggs et al. (2014).

Diagnosis: Distinguished from *L. tenax* by the following combination of characters: caespitose, rhizomes not extended; culms stout 1–3(–4) mm diam., culm sheaths few (2–4) with hyaline margins 5–10 mm wide; male spikelets larger; the outer lateral female tepals inflated and convex near the midpoint and with a broad apical wing with a finely laciniate margin.

Type: Western Australia: Dennis Road 0.5 km N of Governor Broome Road, ENE of Augusta, *B.G. Briggs 9821*, 19 Nov 2007 ♀ (holo NSW756791; iso PERTH).

Plants caespitose, forming small erect or rarely large tussocks, regenerating by seed after fire. *Culms* simple below the inflorescence, 1–3(–4) mm diam., c. 20–80 cm long, smooth to substriate or minutely pitted, grey-green. *Culm sheaths* few, 2–4, 1–2.5 cm long, green when young but becoming brown with age, striate, apex acute to truncate; lamina narrow, to 1 cm long; hyaline margin 5–10 mm wide when young but weathering away; lower sheaths often with a green to brown lamina up to c. 4 cm long and c. 1 mm broad. *Male inflorescence* with branches 5–15 cm long, whitish when young with a minute tomentum. *Female inflorescence* narrow, up to c. 12 cm long, with 5–30 erect and often densely clustered spikelets. *Male spikelets* sessile or on drooping or erect filiform pedicels, when young narrow-ellipsoid, 4–8 mm long, 1–2 mm diam., with age becoming ovoid and up to 3 mm diam., with 10–20 glumes, all fertile; glumes ovate-elliptic, 3.5–4.5 mm long, acute to mucronate with a short mucro to c. 0.5 mm long, brown with prominent hyaline margins and a pigmented mid-vein. *Female spikelets* on ± erect, rigid pedicels, cylindrical, 10–15 mm long, 2–5 mm diam., c. 10 glumes, all fertile or 1 or 2 lower glumes sterile; glumes rigid, broad-ovate, red when young, becoming brown, 4.5–8 mm long, glabrous or abaxial surface of lower glumes partially covered by appressed trichomes, tapering into an initially erect but becoming recurved rigid awn 0.5–3 mm long. *Male flowers*: tepals 4–6, membranous, pale brown or hyaline; outer tepals keeled, oblanceolate, mucronate to acuminate, 1.5–2.2 mm long; inner tepals ± equal in length to outer tepals, flat, ovate, obtuse; stamens 3; filaments very short; anthers 1–1.5 mm long; pistillode absent. *Female flowers* dorsiventrally compressed; bracts between glume and flower absent; tepals 6, 2–4 mm long; outer lateral tepals broadly obovate, keeled, the upper half thick, fleshy and convex below a broad laciniate wing; inner tepals flat or slightly keeled, linear-lanceolate, acute, slightly longer than outer; staminodes absent; style 3-branched, shortly connate at the base, the free portion stigmatic, the basal portion persistent on the nut. *Nut* narrow ovoid, 2–2.4 mm long, smooth, yellow-brown. (Fig. 2)

The epithet refers to the handsome appearance of the young male and female inflorescences, the red-brown glumes contrasting with their pale hyaline margins.

Distribution: Western Australia: Swan Coastal Plain, Jarrah Forest and Warren regions: from Bunbury to east of Augusta. Map: Fig. 3.

Conservation status: Widespread and often abundant. In seasonally moist sites with heath and shrubs on peaty sand, clay or laterite.

Note: *Leptocarpus elegans* differs from *L. tenax* in the caespitose habit, stouter culms, fewer culm sheaths, wide membranous margins of culm sheaths, larger male spikelets and the broad wing on the outer female tepals. *Leptocarpus tenax* has extended rhizomes, culms 0.8–2(–2.5) mm diam., culm sheaths 7-10; male spikelets 2–5 mm long; female outer lateral tepals not convex and with a narrower entire wing.

Ferdinand JH von Mueller used the unpublished epithet 'luzuloides' on specimens of this taxon (e.g. Vasse River, *Pries s.n.*, *anno* 1876 ♂ [MEL]) and under *Leptocarpus scariosus* R.Br. referred to specimens with similarity to *Luzula* (Mueller 1873).

Selected specimens examined: Western Australia: Bunbury, *R. Royce 6797,* 20 Feb 1962 ♀ (PERTH); 2 km E of Wonnerup on Ruabon Road, *B. Briggs 7555a and L. Johnson,* 6 Oct 1984 ♂ (NSW, PERTH); 1 km S of Ruabon, *B. Briggs 6743* ♂, *6744*

♀ 10 Oct 1976 (NSW, AD, CANB, MEL, PERTH); Wonnerup Road reserve, 9.5 km ESE from the Bussell Highway, 18 km E of Busselton, *B.J. Keighery and N. Gibson 1053*, 8 November 1993 ♀ (PERTH); Ambergate, Busselton district, *R. Royce 2886* ♂, *2887* ♀ 19 Oct 1948 (PERTH); c. 24 km S of Busselton, 1.1 km SE along Jalbarragup Road from the junction with Sabina Road, *B. Briggs 7565* ♂, *7566* ♀ and *L. Johnson,* 6 Oct 1984 (NSW, PERTH); 5 km N of Brennans Ford (Scott River Crossing) NE of Augusta, *A. Strid 21423,* 16 Nov 1982 ♀ (NSW, C, K, MO, PERTH); Dennis Road, 3.5 km S of Brockman Highway, *B.G. Briggs 9060 and K. Meney*, 13 Oct 1992 ♂, ♀ (NSW, PERTH); 30 m E of Dennis Road, 3.6 km S of junction with Brockman Highway, *P. Ellery and T. Annels SC185.4*, 14 Jan 1997 ♂, ♀ (PERTH); c. 12 km ESE of Alexandra Bridge, 4.3 km S of Brockman Highway on Dennis Road, 27 Oct 1988, *B.G. Briggs 8377 and L. Johnson* ♀ (NSW, K, MO, PERTH); District Murray, *E. Pritzel 133*, Dec 1900 ♂ (K); Swan R., *Drummond 391* ♀ (CGE, K, LD, P).

Leptocarpus tephrinus B.G.Briggs, **sp. nov.**

'Meeboldina tephrina B.G.Briggs & L.A.S.Johnson, unpubl.', Briggs and Johnson (1999), Meney et al. (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002); *Meeboldina* sp. A, Briggs et al. (2014).

Diagnosis: Distinguished from *Leptocarpus tenax* by the female spikelets small, 4.5–5.5 mm long; female glumes pale, soft and hyaline.

Type: Western Australia: 7 km W of Cookernup, *B.G. Briggs 7538 and L. Johnson,* 5 Oct 1984 ♀ (holo NSW396129; iso K, MO, PERTH6174019).

Plants with elongated woody rhizomes, forming diffuse patches to 30 cm across; resprouting after fire. *Rhizomes* 3–5 mm diam, glabrous, mostly covered by scarious cataphylls. *Culms* ascending at the base, the basal 3–5 cm covered by tawny yellow-brown and slightly glossy cataphylls, terete, simple, 1–2 mm diam., 45–70 cm long, smooth to minutely striate, light- to grey-green or occasionally purplish, internodes 6.5–14.5 cm long. *Culm sheaths* few, mostly 5–8, closely appressed to the culm, 1–1.7 cm long, minutely-striate, brown to grey-black, acute; lamina to 7 mm long, weathering away; apical margin hyaline, weathering away, c. 4 mm wide. *Male inflorescence* up to c. 15 cm long, the spikelets erect to drooping on filiform pedicels. *Female inflorescence* narrow, interrupted, up to c. 10 cm long; culms with 10–30(–70) spikelets. *Male spikelets* ovoid, 4.5–5.5 mm long, with 10–16 glumes; glumes ovate, dark brown with clearly defined pale hyaline margins, glabrous, acute to cuspidate, 2–2.5 mm long, with a short erect awn c. 1 mm long, the lowest few shorter and empty. *Female spikelets* ellipsoid, 4–8 mm long, with 8–20 glumes, all fertile or several basal ones empty; glumes lanceolate, aristate, 2.5–3.5 mm long, with an erect to recurved awn to c. 1.5 mm long, glabrous, when young the lower part brown with a distinct hyaline margin, glume becoming hyaline and grey with age. *Male flowers*: tepals 6, brown-hyaline, membranous, glabrous; 2 outer tepals keeled, oblanceolate, cuspidate, 1.0–1.6 mm long, with a very short, erect awn; inner tepals flat, broad-lanceolate, cuspidate, slightly shorter; stamens 3; filaments very short; anthers 0.6–0.8 mm long; pistillode absent. *Female flowers* with a tuft of short, weakly erect, pale hairs at the base; bracts 2, resembling tepals but outer bract shorter; tepals 6, all ± equal, linear, acute to obtuse, 0.7–1.4 mm long, weakly keeled, brown or hyaline, the upper half usually prominently ciliate; style 3-branched, c. 3 mm long, the base shortly connate and persistent on the nut, the upper half stigmatic. *Nut* narrow-ellipsoid, c. 1 mm long, smooth, yellow-brown. (Fig. 4)

The epithet refers to the pale grey colour of older female spikelets; *tephrinos* (Greek) = ash-coloured.

Distribution: Western Australia: Jarrah Forest, Warren and western edge of Esperance regions. Sometimes locally common but in widely scattered locations. Map: Fig. 5.

Conservation status: Not at risk.

Note: Female plants are distinctive with their small female spikelets with young glumes mostly hyaline apart from the keel and older glumes soft and pale grey. Vegetatively plants closely resemble *Leptocarpus tenax*, especially in the ascending culm bases, but the culms are generally more slender and the culm sheaths fewer. It appears that, because of their similarity to a common species, *L. tephrinus* males are rarely collected and more observations on spikelet size are needed to determine whether *L. tephrinus* has consistently larger male spikelets than *L. tenax*. In *L. tenax* the male spikelets are 2-5 mm long and the females are red when young, becoming dark brown, rigid and (0.5–)2–3 cm long.

Selected specimens examined: Western Australia (west to east): 7 km W of Cookernup, *B. Briggs 7537 and L. Johnson*, 5 Oct 1984 ♂ (NSW); 100 m S of Forest Grove Road, 5.7 km W of Bussell Highway, *J. Scott 519* ♂, *520* ♀, 13 Jan 2002 (PERTH); c. 3 km E of Karridale along Brockman Highway, *B. Briggs 8372 and L. Johnson*, 27 Oct 1988 ♀ (NSW); c. 16 km ENE of Karridale, *B. Briggs 7583 and L. Johnson* 6 Oct 1984 ♀ (NSW, CANB, PERTH, PRE, RSA);); c. 3 km E of Alexandra Bridge on Warner Glen Road, 0.5 km NE of Brockman Highway, *B. Briggs 8360 and L. Johnson,* 27 Oct 1988 ♀ (NSW); Northern boundary of Gingilup Swamps Nature Reserve, *N. Gibson and M. Lyons 579,* 18 Apr 1991 ♀ (PERTH); Black Point Road, *R.J. Cranfield 11032,* 11 March 1997 ♀ (PERTH); 6 km S of Northcliffe, *A. George 8671,* 10 Mar 1967 ♂ ♀ (PERTH, NSW); Maringup Road, c. 3 km S of Chesapeake Road junction, *N. Gibson and M.*

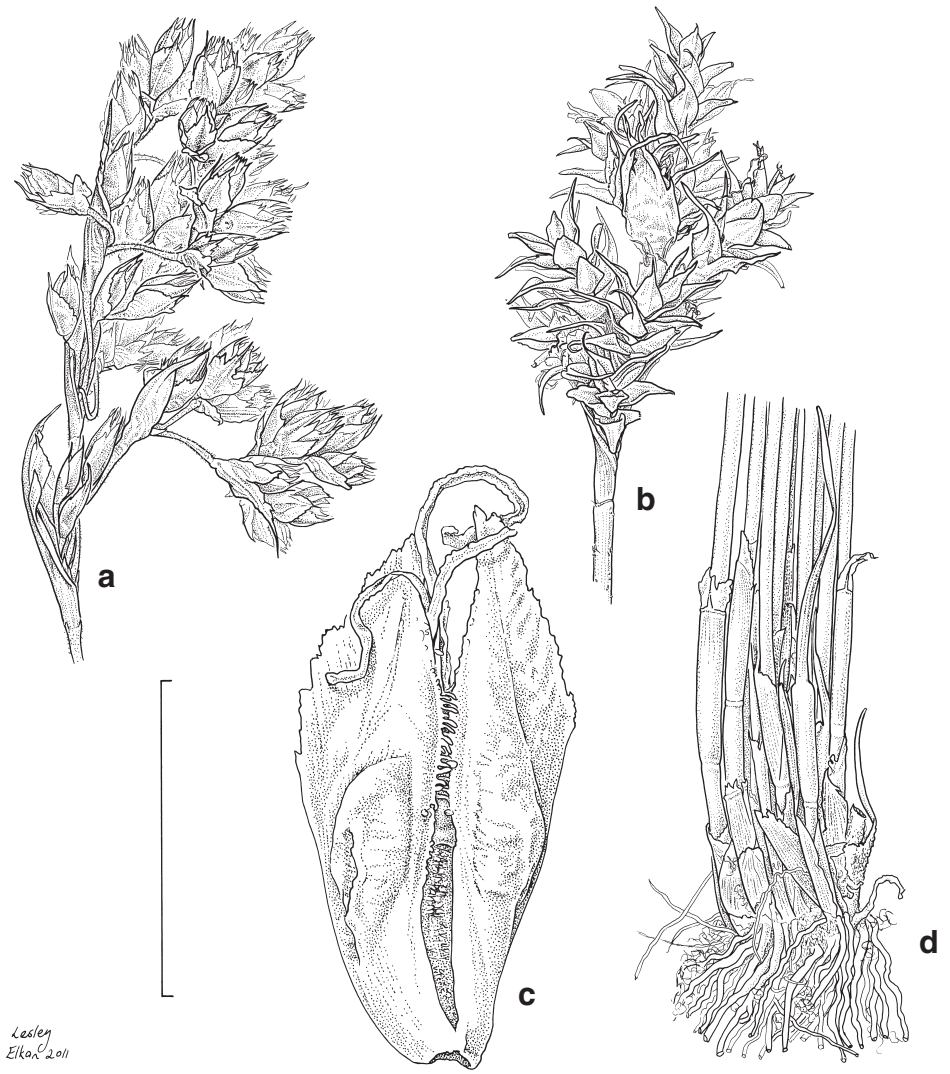

Fig. 2. *Leptocarpus elegans*. **a,** part of male inflorescence (from *Briggs 6743*)**; b,** part of female inflorescence; **c,** female flower; **d,** plant base (b–d from holotype). Scale bar: a, b = 2 cm; c = 0.25 cm; f = 4 cm.

Fig. 3. Distribution of *Leptocarpus elegans*.

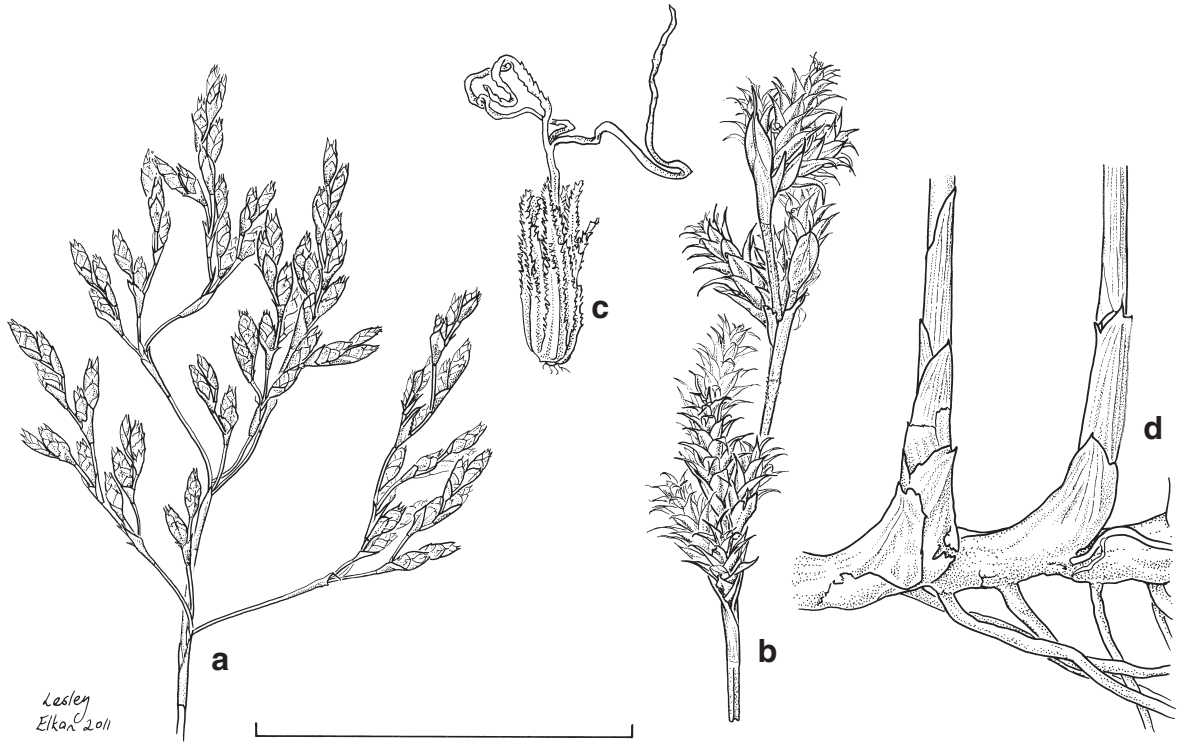

Fig. 4. *Leptocarpus tephrinus*;**. a,** part of male inflorescence (from *Briggs 10107*)**; b,** part of female inflorescence; **c,** female flower with attached bract**, d,** part of rhizome (b–d from holotype) Scale bar: a = 4 cm; b, d = 2 cm; c = 0.25 cm.

Fig. 5 Distribution of *Leptocarpus tephrinus.*

Fig. 6. a–f, *Leptocarpus roycei***; g–l,** *L. decipiens***. a, g**, part of male inflorescence**; b, h,** male spikelets**; c, d, i, j,** part of female inflorescence**; e, k,** female flowers with bracts**; f, l,** plant base**. a, b, f, i–l,** from holotypes**; c, d, e,** from *Briggs 9094***; g, h,** *Briggs 9095***.** Scale bar: a, c, g, i =4 cm; b, d, h, j = 1 cm; e, k = 0.25 cm; f, l =6 cm.

Lyons 625, 4 May 1991 (PERTH); Quarram, *R. Melville 4468 and R.D. Royce*, 31 Jul 1953 ♀ (K, PERTH); 23 miles [37 km] W of Denmark, *R. Royce 4293* ♂, *4294* ♀ 31 Jul 1953 (PERTH); 2 km S of Bow Bridge on Peaceful Bay Road, *B. Briggs 6927,* 19 Nov 1977 ♀ (NSW, AD, BRI, PERTH); near Cuthbert Siding, 6 miles [10 km] W of Albany, *B. Briggs 605b,* 17 Sep 1966 ♀ (NSW, K, MEL, PERTH); 9 km ENE of Manypeaks on Hassell Highway, *B. Briggs 6568, 6569* 4 Oct 1976 ♀ (NSW).

Leptocarpus roycei B.G.Briggs, **sp. nov.**

'Meeboldina roycei B.G.Briggs & L.A.S.Johnson, unpubl.', Briggs and Johnson (1999), Meney et al. (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002); *Meeboldina* sp. E, Briggs et al. (2014).

Diagnosis: Distinguished from *Leptocarpus coangustatus Nees* by the following combination of characters: caespitose; culms stouter (2.5–4.5[–6] mm diam. near base); male spikelets longer (4–11 mm long); male glumes scarcely glossy; female inflorescence highly ramified, mostly forming a cluster of long branches (to c. 50 cm long) bearing spikelets crowded on very short lateral branches.

Type: Western Australia: Forrestdale, corner of Forest Road and Nicholson Road, *B.G. Briggs 9093 and K. Meney*, 17 Oct 1993 ♂ (holo NSW261800; iso CANB, K, PERTH).

Plants forming large dense tussocks to 30 cm across; regenerating by seed; base with pale-brown cataphylls and pale-brown woolly pubescence. *Culms* terete, stout 2.5–4.5(–6) mm diam. near base, 125–140 cm long, finely striate, grey-green; internodes 7.5–13.5(–16) cm long. *Culm sheaths* 11–25 mm long, tan to grey-brown, apex mucronate; lamina narrow, blunt, persistent, 6–8 mm long; apical margin 2.5–5.5 mm wide, membranous, weathering away. *Inflorescence*: large, much branched, spikelets very numerous; males semi-erect or pendulous on fine branchlets; females forming a cluster of branches to c. 50 cm long bearing spikelets crowded on very short, 2–3 mm long lateral final branches. *Male spikelets* ovoid to cylindrical, 4.5–11 mm long, glumes 12–38, all fertile or several lower glumes sterile or with abortive flowers; glumes ovate, acuminate to aristate, 1.7–2.7 mm long with a short awn to 0.4 mm long, glabrous, red-brown, slightly glossy, the apical one-third hyaline. *Female* spikelets 2–3 mm long; glumes lanceolate to ovate, acuminate, glabrous, 0.8–1.5 mm long,

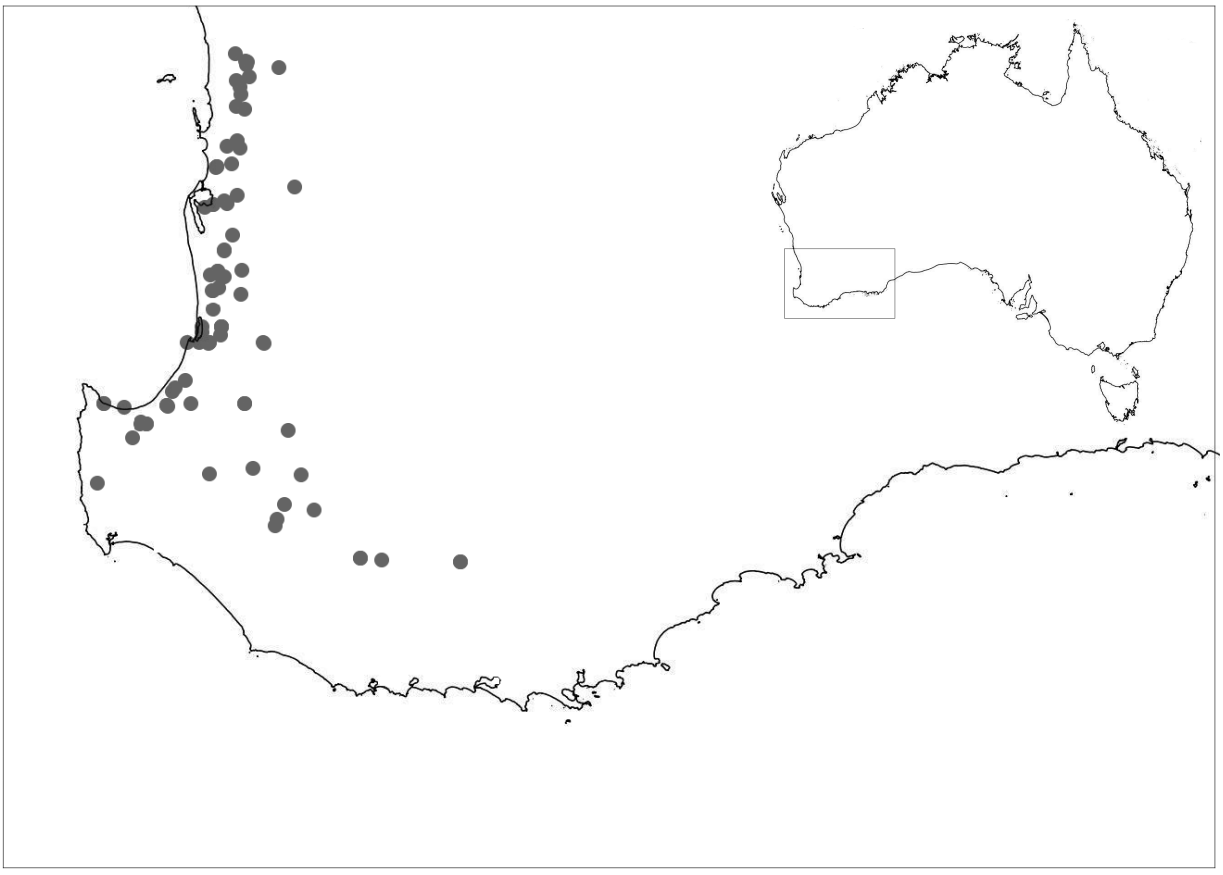

Fig. 7. Distribution of *Leptocarpus roycei*.

equal in length to tepals. *Male flowers*: tepals 5(or 6), membranous, acute, 0.9–1.5 mm long; outer tepals keeled, lanceolate, always brown-pigmented, cuspidate; inner tepals flatter and broader, lanceolate to broad-ovate, hyaline or pigmented, either slightly shorter or slightly longer; stamens 3; filaments 0.3 mm long; anthers c. 0.6–0.9 mm long; pistillode absent. *Female flowers*: base with pale hairs; bracts ovate, shorter than tepals, toward the apex hyaline and pigmented only along the keel; tepals 6, red-brown, flat or slightly keeled, linear-lanceolate, acute, 1–1.4 mm long, tepals equal or inner slightly shorter, abaxial surface papillate; margin shortly ciliate; staminodes absent; style 3-branched, branches wholly stigmatic, base persistent on the nut. *Nut* narrow ovoid-trigonous, 1–1.3 mm long, yellow-brown. Chromosome number $2n = 24$. (Fig. 6a–f)

The epithet commemorates Robert Dunlop Royce (1914–2008), botanist at the Western Australian Herbarium from 1944 and Curator of that herbarium 1960–1974. Bob Royce collected numerous excellent specimens of Restionaceae, carefully matching males and females of dioecious species.

Distribution: Western Australia: Swan Coastal Plain, Jarrah Forest and probably Warren regions: from Wanneroo (northern Perth district) south to Busselton, Manjimup and Frankland, probably also less commonly near Augusta, in sedge- or shrub-swamps and on river banks, on clay soil or peaty sand. Map: Fig. 7.

Conservation status: Widespread and common, although many occurrences are in regions subject to urbanisation and environmental change.

Note: See Table 1 for differences between the caespitose species *L. roycei, L. decipiens* and *L. depilatus*. *Leptocarpus coangustatus* differs from *L. roycei* in its extended rhizomes, culms 0.5–2 mm diam.; male spikelets shorter, 4–7 mm long; male glumes glossy with a pale hyaline margin and female inflorescence with few branches.

Selected specimens examined: Western Australia: Neaves road, c. 15 km NE of Wanneroo, *B. Briggs 7234 and L. Johnson*, 18 May 1983 ♂ (NSW, CANB, MEL, PERTH, RSA); Kewdale, *R. Coveny 8196*, 7 Sep 1976 ♀ (NSW); Cannington, *A. Morrison*, 10 Jan 1899 ♂, ♀ (E, K); Forrestdale, corner of Forest Road and Nicholson Road, *B.G. Briggs 9094 and K. Meney*, 17 Oct 1993 ♀ (NSW, CANB, K, MO, PERTH); 7 km WSW of Waroona, *B. Briggs 6682*, 9 Oct 1976 ♂ (NSW, PERTH); Cookernup, *R. Royce 3138* ♂, *3139* ♀, 10 Oct 1949 (PERTH); 3.1 km W of Cookernup on Riverdale Road, *B. Briggs 8298 and L. Johnson*, 25 Oct 1988 ♀ (NSW); 9 km W of Harvey on road to Myalup Beach, *B. Briggs 6693*, 9 Oct 1976 ♀ (NSW, AD, MEL, PERTH), *6694* ♂ (NSW); Brunswick Junction, *P. Wilson 6258* ♂, *6259* ♀, 29 Sep 1967 (PERTH, CANB, NSW); 0.5 km S of Brunswick Junction, *B.G. Briggs 9043 and K. Meney*, 13 Oct 1992 ♂ (NSW, CANB, PERTH); Roelands, *R.D. Royce 3073* ♂, *3074* ♀, 15 Jul 1949 (PERTH); 20.3 km E of Roelands on Collie Road, *B. Briggs 8300 and L. Johnson,* 25 Oct 1988 ♀ (NSW, PERTH); 5 miles [8 km] N of Bunbury, *B. Briggs* 22 Sep 1966, *814* ♂ (NSW, NBG, PERTH), *815* ♀ (NSW, CBG, HO); 2 km E of Wonnerup on Ruabon road, *B. Briggs 7546 and L. Johnson*, 6 Oct 1984 ♂ (NSW); 2.8 km S of Quindalup, *B. Briggs 8318 and L. Johnson,* 26 Oct 1988 ♀ (NSW, PERTH); Ambergate, c. 6 km S of Busselton, *B.G. Briggs 800*, 21 Sep 1966 ♂ (NSW); Manjimup, *B.G. Briggs 10113*, 8 Nov 2010 ♂ (NSW, PERTH); north side of Tuckers Road, 16.5 km ESE of Frankland, *M.N. Lyons 4748 and S.D. Lyons*, 13 Nov 1999 (PERTH, NSW).

Leptocarpus decipiens B.G.Briggs, **sp. nov.**

'Meeboldina decipiens B.G.Briggs & L.A.S.Johnson subsp. decipiens, unpubl.', Briggs and Johnson (1999), Meney *et al.* (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002); *Meeboldina* sp. B, Briggs et al. (2014).

Diagnosis: Distinguished from *Leptocarpus roycei* by the following combination of characters: culms slender, 2–3 mm diam. near base; male spikelets ovoid, 3.5–5.5 mm long, glumes glossy tan-brown; bracts of female flowers ovate, shorter than tepals, toward the apex hyaline and pigmented only along the keel; outer female tepals lanceolate to spathulate, blunt or tapering abruptly. Differing from *L. depilata* in its shorter, more slender culms, shorter inflorescence branches and ovoid female flowers.

Type: Western Australia: 0.5 km S of Brunswick Junction (site of Waterloo State School); *B.G. Briggs 9045 and K. Meney*, 13 Oct 1992 ♀ (holo NSW261627; iso PERTH8372543)

Plants forming slender and few-stemmed tufts to large dense tussocks to 40 cm across, regenerating by seed; base with pale-brown cataphylls and a pale-brown woolly pubescence. *Culms* terete, 2–3(–5) mm diam. near base, 50–85 cm long, striate, grey-green, toward the base often tinged pink or grey; internodes 3–9 cm long. *Culm sheaths* 10–15 mm long, striate, closely appressed, tan to grey-brown; lamina narrow, blunt, persistent, 3.5–7 mm long; membranous margin 1.5–3 mm wide, weathering away. *Inflorescence*: sparsely branched; male spikelets semi-erect to drooping on long slender branchlets; female inflorescence slender, spikelets crowded on short (to 5 cm long) final branches and in the upper 5–10 cm of the inflorescence; spathes ovate, 0.9–1.2 mm long, margins tomentose, though may appear glabrous due to weathering. *Male spikelets* ovoid, 3.5–5.5 mm

Table 1. Distinguishing features of *Leptocarpus roycei*, *L. decipiens* and *L. depilatus*.

Structure	*L. roycei*	*L. decipiens*	*L. depilatus*
culms	tall to 1.5 m, stout 2.5-4.5(-6) mm diam., much branched	short to 0.9 m, slender 2-3(-5) mm diam., with few branchings	tall to 1.6 m, stout 2-5 mm diam., much branched
♂ spikelets	ovoid to cylindrical, 4-11 mm long	ovoid, 3.5-5.5 mm long	ovoid to cylindrical 4-8 mm long
♂ glumes	not or slightly glossy	glossy	glossy
♀ inflorescence branches	mostly a cluster of many long (to 50 cm) branches with spikelets crowded on very short (2–3 mm) lateral final branches	few and short (to 5 cm) branches with crowded fascicles of spikelets	long with spikelets well-spaced, mostly on short (to 2 cm) lateral branches
♀ glumes	lanceolate to ovate, acuminate, not glossy	ovate, blunt or shortly acuminate, not glossy	lanceolate, acuminate, glossy
♀ glume hyaline apical margins	narrow	broad	very narrow
♀ flowers	cylindrical to narrow ellipsoid	ovoid	cylindrical to narrow ellipsoid
♀ outer floral bract	lanceolate, nearly as long as outer tepals	ovate to lanceolate, c. ½ as long as tepals	lanceolate, nearly as long as tepals
♀ outer tepals	linear-lanceolate, margins shortly ciliate	broad lanceolate to spathulate, distally only the keel pigmented, margins white tomentose	linear-lanceolate, margins shortly ciliate
distribution	Wanneroo to Busselton, Manjimup and Frankland	near Perth to Busselton and Bridgetown	Nannup and Lake Muir to near Albany

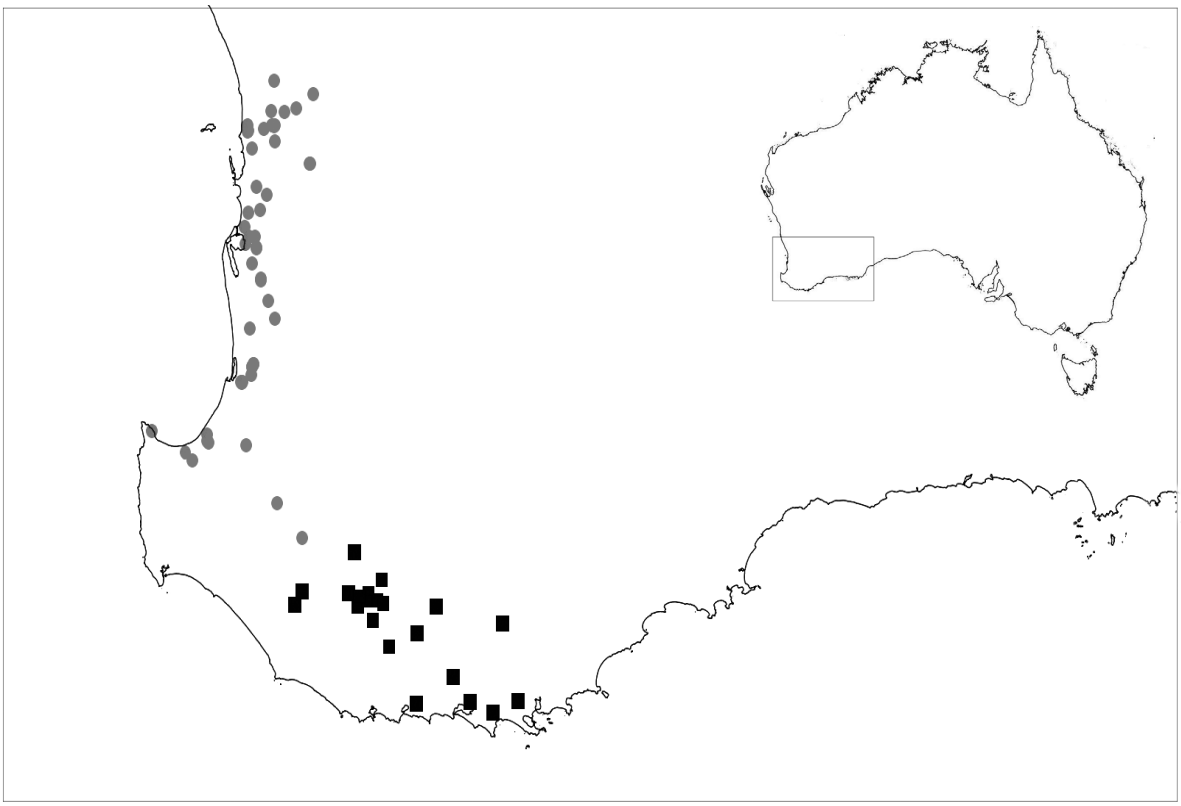

Fig. 8. Distribution of *Leptocarpus decipiens* (dots) and *L. depilatus* (squares).

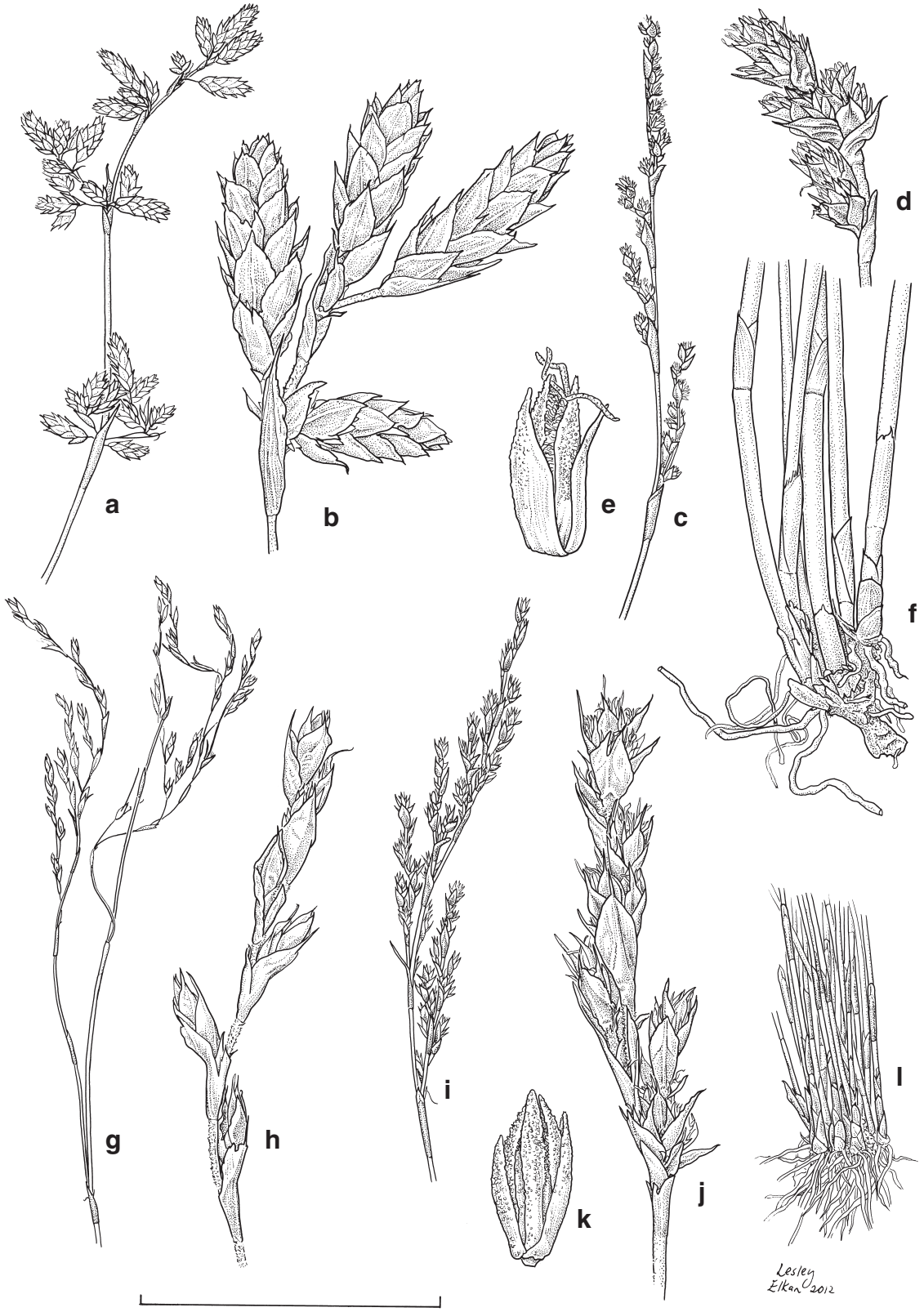

Fig. 9. a–f, *Leptocarpus depilatus***; g–l,** *L. crebriculmis***. a, g,** part of male inflorescence; **b, h**, male spikelets; **c, d, i, j**, part of female inflorescence; **e, k** female flowers with bracts; **f, l**, plant base. **a, b, f, i–l**, from holotypes; **c–e**, *Briggs 6944*; **g, h**, *Wilson 2856*. Scale bar: a, c, g, i = 4 cm; b, d, h, j =1 cm; e, k = 0.25 cm; f, l =6 cm.

long; glumes 11–27, all fertile, ovate, acuminate to aristate, 1.4–2 mm long with a short awn to 0.6 mm long, glossy red-orange-brown, the apical one-third hyaline. *Female spikelets* 2–5 mm long; glumes lanceolate to ovate, acuminate, glabrous, 1–1.5 mm long, shorter than tepals. *Male flowers* sessile to shortly pedicellate: tepals 5–6, hyaline, acute, 0.9–1.6 mm long; outer tepals keeled, linear to lanceolate, pigmented only along keel, cuspidate; inner tepals flatter and broader, lanceolate to broad-ovate, inner tepals usually slightly longer; stamens 3; filaments 0.3 mm long; anthers c. 0.8 mm long; pistillode absent. *Female flowers*: base with long pale hairs; bracts ovate, ½ as long as tepals, margins hyaline; tepals 6, outer tepals broad lanceolate to spathulate, blunt or tapering abruptly, hyaline, toward the apex pigmented only along keel, surface glabrous or papillate, margins densely white tomentose, acute, 1.2–1.5 mm long; staminodes absent; style 3-branched, branches wholly stigmatic, base persistent on the nut. *Nut* narrow ovoid, 1–1.3 mm long, yellow-brown. (Fig. 6g–l)

The epithet is from the Latin *decipio* = to deceive, entrap or elude, referring to the difficulty of distinguishing this species from *L. roycei*.

Distribution: Western Australia: Swan Coastal Plain and Jarrah Forest regions: from near Perth to Busselton and Bridgetown; mostly in seasonally wet *Melaleuca* swamps on sand or clay. Map: Fig. 8.

Conservation status: Widespread and common.

Note: At some sites, such as 0.5 km S of Brunswick Junction, *L. roycei* and *L. decipiens* co-occurred in 1992, apparently without hybridisation, but by 2010 this site had been cleared of native vegetation.

Selected specimens examined: Western Australia: Between Chidlow and Wooroloo, Old Northam road 3.6 km W from junction with Great Eastern Highway, *R. Spjut, G. White and R. Phillips 7175*, 23 Sep 1981 (PERTH); Kewdale, *R. Coveny 8196*, 7 Sep 1976 ♀ (NSW); Cannington Swamps, Yule Brook Reserve, *P. Ladd*, 8 Dec 2010 ♂ (NSW), ♀ (NSW, PERTH); Ranford Road 2.9 km S of Warton Road, Gosnells, *B.G. Briggs 9411 and J. Pate*, 8 Oct 1995 ♂ (NSW, PERTH), *9412* ♀ (NSW, CANB, K, MO, PERTH); Canning River East Branch, Water Reserve, City of Armadale, *F.Hort, J. Hort and L. Boyle 3395* ♂, *3396* ♀ (PERTH, NSW); Brickwood Reserve, Byford, between Turner and Soldier Roads, *M. Hislop MK 6-16*, 14 Nov 2003 ♀ (PERTH); Hampton Road, Pinjarra, *B.J. Keighery 2178*, 17 Nov 1995 ♂, ♀ (PERTH); Austin Bay Nature Reserve, WSW of Grey Road, *B.J. Keighery and N. Gibson 116*, 9 Sep 1993 ♀ (PERTH); N side of Tonkin Road, c. 1 km W of Yunderup Road North, Pinjarra, *P.G. Payne 47*, 6 Sep 2002 ♀ (PERTH); Brunswick Junction, *R.D. Royce 3151*, 11 Oct 1949 ♂ (PERTH); Waterloo, *R.D. Royce 3108*, 14 Sep 1949 ♀ (PERTH); Waterloo, 0.3 km W of School site, *B.G. Briggs 9095 and K. Meney*, 13 Oct 1992 ♂ (NSW, K, MEL, MO, PERTH); *9096* ♀ (NSW, PERTH); Yangedi Swamp, *B.J. Keighery 2431*, 28 Nov 1995 ♂ (PERTH, NSW); McNeill Road, c. 50 m S of Mayfield Road, Waroona, *B.G. Briggs 9101 and K. Meney*, 17 Oct 1992 (NSW, PERTH); 1 km E. of Ruabon, *B.G. Briggs 6737*, 10 Oct 1976 ♀ (NSW); Dunsborough, *B.G. Briggs 6459*, 2 Oct 1976 ♀ (NSW), *6458* ♂ (NSW, AD, PERTH); 4 km S of Busselton on Ambergate road, *B.G. Briggs 767*, 21 Sep 1966 ♀ (NSW, PERTH); South Western Highway 21.5 km S of Bridgetown, *B.G. Briggs 10117* ♂, *10118* ♀, 8 Nov 2010 (NSW, AD, CANB, PERTH).

Leptocarpus depilatus B.G.Briggs, **sp. nov.**

'Meeboldina decipiens B.G. Briggs & L.A.S. Johnson subsp. depilata B.G. Briggs & L.A.S. Johnson, unpubl.', Briggs and Johnson (1999); Meney et al. (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002); *Meeboldina* sp. C. (Briggs et al. 2014).

Diagnosis: Distinguished from *Leptocarpus roycei* by the following combination of characters: male spikelets on short branches usually clustered at upper nodes, each with several (3–20) spikelets. Male spikelets ovoid to cylindrical, 4–8 mm long; glumes tan-brown, glossy, with sharply distinct hyaline margins. Female glumes glossy. Differing from *L. decipiens* in the taller and stouter culms, longer inflorescence branches and male spikelets, and the narrower female flowers.

Type: Western Australia: Thompsons Road, c. 55 km N of Walpole, 6 km S of Muirs Highway, *B.G. Briggs 6945*, 20 Nov 1977 ♂ (holo NSW299931; iso PERTH).

Plants forming large dense tussocks to 30(–50) cm across at base; with pale-brown cataphylls and base with a pale-brown woolly pubescence. *Culms* terete, tough and wiry, 2–5 mm diam. near the base, 50–160 cm long, often arching outwards so that the tussock extends >1 m across, inconspicuously striate, grey-green; internodes 5–12 cm long. *Culm sheaths* 15–25 mm long, striate, tan to grey-brown, apical membranous margin 1.5–5 mm wide, often weathering away. *Inflorescence* much-branched; male spikelets on fine branchlets, mostly clustered at the upper nodes; female spikelets crowded on final branches in the upper 5–10 cm of the inflorescence. *Male spikelets* ovoid to cylindrical 4–8 mm long, glumes 12–18, all fertile; glumes ovate, acuminate to aristate, 2–3 mm long with a short awn to 0.4 mm long, glabrous, glossy tan-brown, mostly with broad hyaline margins. *Female spikelets 2*–5 mm long; glumes lanceolate, acuminate, glabrous, 1–1.5 mm long, equal in length to flowers. *Male flowers* sessile to shortly pedicellate: tepals 5 or 6, membranous, acute, 0.9–1.6 mm long; outer tepals keeled, linear-lanceolate, pigmented only along keel; inner tepals flatter and broader, lanceolate to broad-ovate, longer than outer tepals; stamens 3; filaments 0.3 mm long; anthers c. 0.8–1.2 mm long; pistillode absent.

Female flowers: base with pale hairs; bracts nearly as long as tepals, acute to acuminate, apical margin ciliate; tepals 6, red-brown, linear-lanceolate, flat or slightly keeled, acute, 1.2–1.5 mm long; surface papillate, margins ciliate to densely tomentose, inner tepals slightly longer; staminodes absent; style 3-branched, branches wholly stigmatic, base persistent on the nut. *Nut* narrow ovoid-trigonous, 1–1.3 mm long, yellow-brown. (Fig. 9a–f)

The epithet refers to the female tepals and bracts developing less dense tomentum than in *L. decipiens*: Latin *de-* = departure or removal; *pilus* = hair.

Distribution: Western Australia: Warren region, including Nannup, Lake Muir and south to Denmark and near Albany; in seasonally or permanently moist sites, in sedge- or *Melaleuca*- swamps and near rivers or lakes, on peaty sand. Map: Fig. 8.

Conservation status: Widespread and common.

Selected specimens examined: Western Australia: Blackwood foreshore, Nannup, *M. Hislop 3139*, 14 Dec 2003 ♂, ♀ (PERTH, NSW); South Western Highway 20.5 km S of Bridgetown, *B.G. Briggs 10119*, 8 Nov 2010 (NSW, PERTH); Lake Muir, N end of Lake, beside walkway to bird observatory, *B.G. Briggs 9955*, 24 Oct 2008 ♀ (NSW, PERTH); NE edge of Lake Muir, at Lake Muir Lookout, *B.G. Briggs 10081* ♂, *10082* ♀, 6 Nov 2010 (NSW, CANB, K, MO, PERTH); Muirs Highway, c. 8 km W of Thompson road, *B.G. Briggs 9953*, 24 Oct 2008 ♂ (NSW, PERTH); Muir Highway, 13.1 km E of Thompson Road, *R. Davis 4892B*, 22 Jan 1998 (PERTH); Eastern shore of Lake Muir, c. 3.5 km south of Muirs Highway, *B.G. Briggs 8419 and L. Johnson*, 24 Oct 1988 ♂ (NSW, CANB, MEL, PERTH); 50 km ESE of Manjimup, S boundary of Kodjinup Nature Reserve, *M.N. Lyons and S.D. Lyons 4745*, 10 Nov 1999 (PERTH, NSW); Tuckers Road, 16.5 km ESE of Frankland, *M.N. Lyons and S.D. Lyons 4748*, 13 Nov 1999 (PERTH, AD, MEL, NSW); Biro Road, 9.4 km E of Suez Road, S of Rocky Gully, *R. Davis 4836B*, 19 Jan 1998 ♂ (PERTH); Roe Road crossing on Frankland River, *A.R. Annels 1560*, 14 Dec 1990 ♂ (PERTH); Tudor, 14.3 km east-southeast of Denmark River on South Coast Highway, *B.G. Briggs and L. Johnson*, *8453*♂, *8454* ♀ 29 Oct 1988 (NSW, PERTH); South Coast Highway E of Denmark, 0.5 km W of Sleeman River, *B.G. Briggs 9981*, 26 Oct 2008 ♂ (NSW, PERTH, CANB); Stanley Road at South Coast Highway, c. 26 km W of Albany, *B.G. Briggs 10069*, 5 Nov 2010 ♂ (NSW, AD, BRI, K, PERTH), *10070* ♀ (NSW, MEL, PERTH).

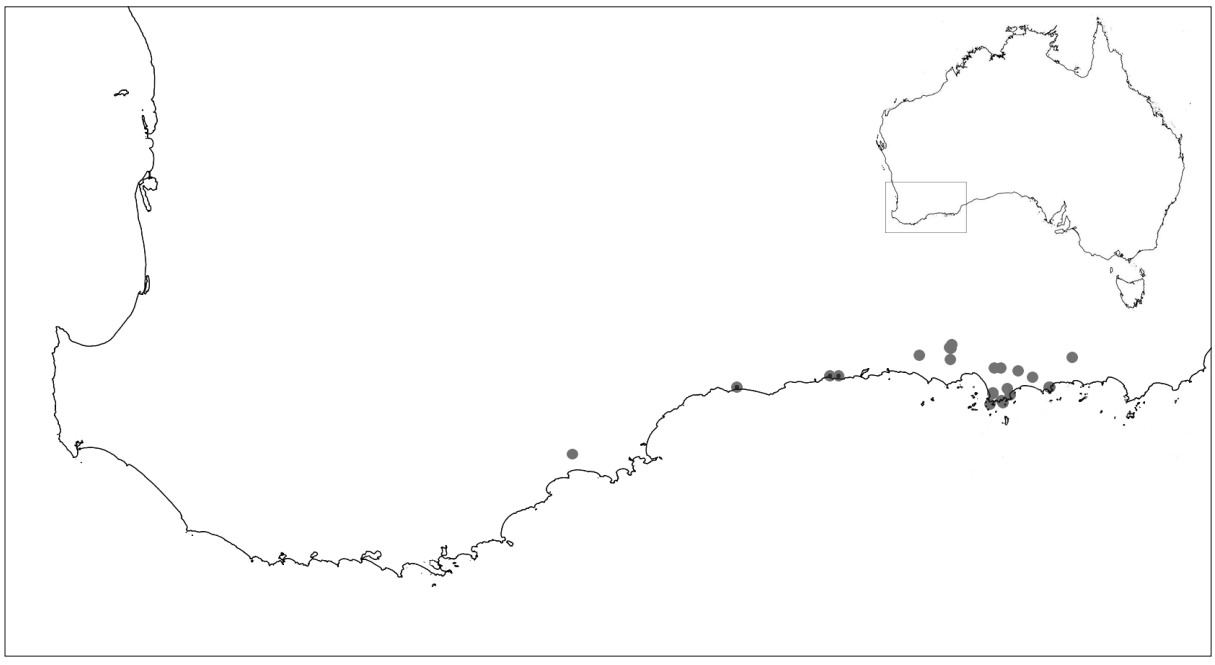

Fig.10. Distribution of *Leptocarpus crebriculmis*.

Fig. 11. a–f, *Leptocarpus kraussii***; g–l,** *L. thysananthus***. a, g,** part of male inflorescence**; b, h**, male spikelets; **c, d, i, j**, parts of female inflorescences; **e, k** female flower with bract; **f, l**, plant base. **c–f, i–l**, from holotypes; **a, b,** from *Briggs 6622*; **g, h,** *Briggs 8330*; **k**, *Briggs 6713*. Scale bar: a, c, g, i = 4cm; b, d, h, j =1 cm; e, k = 0.25 cm; f, l =6 cm.

Fig. 12. Distribution of *Leptocarpus kraussii*.

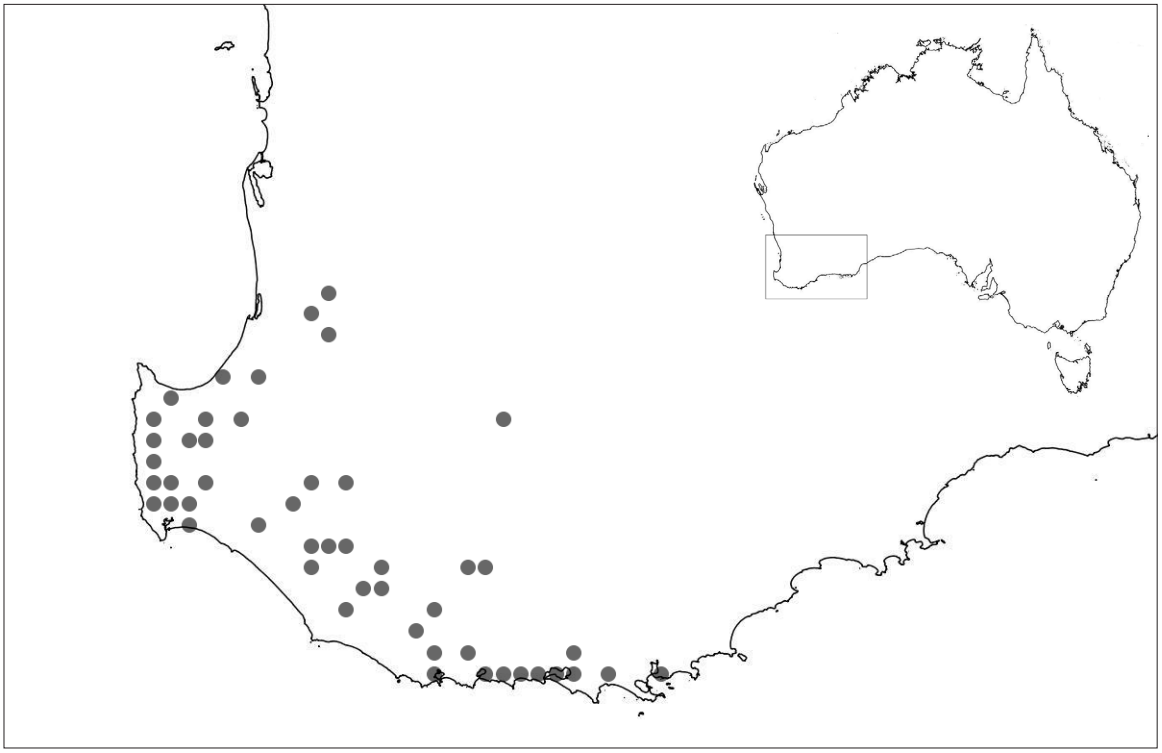

Fig. 13. Distribution of *Leptocarpus thysananthus*.

Leptocarpus crebriculmis B.G. Briggs, **sp. nov.**

'Meeboldina crebriculmis B.G.Briggs & L.A.S.Johnson, unpubl.', Briggs and Johnson (1999); Meney et al. (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002).

Diagnosis: Distinguished among the species of *Leptocarpus* by the following combination of characters: caespitose; culms slender; male spikelets small, 2–3 mm long, and numerous, not glossy; female spikelets small, 2–3 mm long; flowers small with tepals 1–1.3 mm long, glumes and tepals acuminate.

Type: Western Australia: Between Lucky Bay and the entrance to Cape Le Grand National Park, 24 Sep 1974, *S. Carlquist 5773* ♀ (holo: NSW396140; iso: CANB!, MEL!, PERTH!, RSA!).

Plants forming large dense tussocks to 0.8(–1) m across. *Culms* terete, usually simple below the inflorescence, 0.5–1.5 mm diam., 35–100 cm long, striate and often also pitted, dull grey-green to brown; internodes 5–7.5 cm long. *Culm sheaths* 0.6–1.3 cm long, striate to pitted, brown to red-brown, truncate to cuspidate; lamina erect, 2–8 mm long; membranous margin weathering away, up to c. 6 mm wide. *Inflorescence* narrow, interrupted, up to c. 20 cm long; male spikelets on numerous, fine inflorescence branches, spathes with broad hyaline margins; female spikelets crowded on short branches in upper 10–15 cm of inflorescence. *Male spikelets* narrow ovoid, brown, not glossy, 2–3 mm long. *Female spikelets* 2–3 mm long; glumes lanceolate, acute to acuminate, 2–2.5 mm long, brown, with broad membranous margin, glabrous. *Male flowers*: tepals 6; 3 outer tepals keeled, lanceolate, acute, 1–1.3 mm long, brown-hyaline, glabrous; inner tepals flat to concave, ovate, acuminate, slightly shorter than the outer tepals, red-brown-hyaline, glabrous; stamens 3; filaments very short; anthers 0.5–0.8 mm long; pistillode absent. *Female flowers*: bracts narrow-lanceolate, c. 1 mm long, margin finely ciliate; tepals 5 or 6, oblong-lanceolate, acute, 1–1.3 mm long, margins membranous; outer tepals often shortly ciliate or fimbriate, keeled; inner tepals with fimbriate margin, usually flat; style 3-branched, wholly-stigmatic. *Nut* trigonous, papillate, 0.8–1.2 mm long, yellow-brown. *Seed* ellipsoid, c. 0.8 mm long. (Fig. 9g–l)

The epithet refers to the usually closely-spaced culms : Latin: *creber* = close, pressed together, numerous; *culmus*, *culmis* = stem, stemmed.

Distribution: Western Australia: Esperance region: from near Bremer Bay to Duke of Orleans Bay and Howick Hill. In seasonally moist sites in a semi-arid region. On peaty sand or clay, mostly in sedge-heath surrounded by eucalypt woodland. Map: Fig. 10.

Conservation status: Reasonably widespread and well represented in National Parks. Fire response is not recorded.

Selected specimens examined: Western Australia (west to east): Yellilup Swamp, 38km W of Bremer Bay, 5 km NW of intersection of Borden–Bremer Bay Road and Gairdner Road South, *M.N. Lyons 4651*, 16 Dec 2000 (PERTH, NSW); 0.3 km N along fence line from southern boundary of Barren Beach Estate (Hopetoun), 0.7 km E of Pardalotle Parade, *M. Bennett 1222*, 31 Dec 2008 ♀ (PERTH, NSW); c. 14 km E of the mouth of the Oldfield River, *A. Orchard, 1503* 12 Oct 1969 ♀ (AD, NSW, PERTH); c. 24 km N of Esperance, *P. Wilson 3048b*, 12 Nov 1964 ♂ (AD, NSW); 1.5 miles [2 km] S of Gibson, *B. Briggs 338*, 9 Sep 1966 ♀ (NSW, AD, CANB, PERTH); Merivale Road, c. 25 km ENE of Esperance on road to Cape Le Grand National Park, *S. Krauss 177* and *L. Howitt*, 5 May 1989 ♂ (NSW, PERTH), *178* ♀ (NSW, K, LH, PERTH); Base of Hill 49, Cape Le Grand National Park, *R.J. Cranfield 1367*, 19 Nov 1979 (PERTH); Cape Le Grand National Park, *A. Weston 7082,* 7 Nov 1971 ♀ (PERTH, NSW), *8303,* 19 Jul 1973 ♀ (PERTH, NSW); near Whartons campsite on W end of Duke of Orleans Bay, *T. and J. Whaite 4316,* 16 Oct 1976 ♂ (NSW); c. 10 km ESE of Howick Hill, c. 65 km ENE of Esperance, *N.N. Donner 2622*, 18 Sep 1968 ♂ (AD).

Leptocarpus kraussii B.G.Briggs, **sp. nov.**

'Meeboldina kraussii B.G.Briggs & L.A.S.Johnson, unpubl.', Briggs and Johnson (1999), Meney et al. (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002); *Meeboldina* sp. D, Briggs et al. (2014).

Diagnosis: Differing from *L. canus* in the elongated rhizomes with culms generally spaced 3–5 mm apart; male spikelets about as wide as long with dull, red-brown or blackish glumes; female inflorescence reddish or blackish and tepals narrow.

Type: Western Australia: Near Strachan, 47 km ESE of Manjimup on Muirs Highway, 32°24' S 116°32'E, 28 Oct 1988, *B.G. Briggs 8407 and L. Johnson* ♀ (holo: NSW212482; iso CANB 723214, K, MO, PERTH6174078).

Plant forming diffuse patches 0.3–1 m across, resprouting after fire. *Rhizome* horizontal, 3–6 mm diam., with pale woolly hairs covered by orange-brown scarious cataphylls. *Culms* terete, unbranched below the inflorescence, 0.5–1.5 mm diam., 0.3–0.6 m long, striate, light- to grey-green or purplish brown; internodes 5–6 cm long. *Culm sheaths* 0.7–1.5 cm long, striate, green to pale-brown, darkening with age, apex mucronate with a narrow mucro 1–5 mm long; membranous margin hyaline, weathering away, c. 2 mm wide. *Male*

inflorescence narrow, interrupted, up to c. 10 cm long; spikelets on short branches or pedicellate at upper nodes. *Female inflorescence* of spikelets crowded on short lateral branches in the upper 10–15 cm of an interrupted inflorescence. *Male spikelets* pedicellate; the pedicels filiform, tomentose, up to c. 1 cm long; spikelets at first narrow-ovoid, becoming ovate in outline with spreading glumes, 4–9 mm long, with c. 6–14 glumes, usually all fertile; glumes ovate, membranous, red-brown hyaline often becoming black, glabrous, acute to acuminate, 2–3.5 mm long. *Female spikelets* often crowded into small clusters, the clusters distant or crowded on short branches or ± sessile on the culm, 2–4 mm long, narrow-ellipsoid and brown when flowering but spreading and becoming ± globose and red-brown when fruiting, with up to 50(–80) flowers; glumes broad-ovate, acuminate, reddish-brown or almost black, margins membranous, glabrous, 1–1.5 mm long, 0.7–1 mm wide. *Male flowers*: tepals 5 or 6; outer tepals keeled, oblanceolate, acuminate, 1–1.5 mm long, brown-hyaline; inner tepals flat, lanceolate, acute to cuspidate, 0.5–1.3 mm long; stamens 3; anthers 1–1.5 mm long; filaments stout, 0.3–0.6 mm long, the base swollen and merging into a globose receptacle c. 0.5 mm diam. *Female flowers*: tepals 6, narrow-lanceolate to oblanceolate, acute to acuminate, 1–2 mm long, brown-hyaline, the margins shortly and densely fimbriate; staminodes absent; style 3-branched, filiform, almost wholly free and stigmatic, c. 2 mm long, the base persistent on the nut; bracts keeled, lanceolate, acuminate, brown-hyaline, densely fimbriate on margin, 1–2 mm long. *Nut* trigonous, brown, c. 1.5 mm long. *Seed* c. 1 mm long. (Fig. 11a–f)

The epithet commemorates Dr Siegfried L. Krauss, of Kings Park and Botanic Garden, Perth, who gave excellent assistance to studies of Restionaceae and first recognised the distinctiveness of this species.

Distribution: Western Australia: Swan Coastal Plain, Jarrah Forest, Warren and Esperance regions: near Perth and from the Beaufort River east and south to east of Hopetoun; in seasonally moist sites. Map: Fig. 12.

Conservation status: Widespread and common.

Note: Most similar to *L. canus* and previously included in the latter. *Leptocarpus canus* has a more northerly (but overlapping) distribution, from near Cataby to Beaufort River, and has culms crowded on very short rhizomes up to 1(–4) cm long, giving a tufted appearance; male spikelets glossy yellow-brown; female inflorescence with a yellowish-brown cast, tepals broader, and fruiting inflorescence more conspicuously white tomentose.

Selected specimens examined: Western Australia: Mt Cooke Pine Plantation, 0.5 km E of Albany Highway, 7 km SE of Jarrahdale Road, *B.G. Briggs 9399 and J.S. Pate*, 8 Oct 1995 ♂ (NSW, PERTH); 775 m N on Cundinup–Nannup Road from intersection with Vera Road, *C. Day and C. Godden B 97.9*, 24 Jan 1997 (PERTH); Three Acre Pool, 4 km SE of Bridgetown, *G. Wardell-Johnson 47*, 9 Feb 1992 ♀ (PERTH, NSW); Manjimup, *M. Koch 2645*, Oct 1921 ♀ (NSW, PERTH); near Strachan, 47 km ESE of Manjimup on Muirs Highway, *B. Briggs 8406 and L. Johnson*, 28 Oct 1988 ♂ (NSW, PERTH); W side of Lake Muir, 4.2 km S of Muirs Highway along Thomsons Road, *B. Briggs 8421 and L. Johnson*, 28 Oct 1988 ♂ (NSW), 8422 ♀ (NSW, CANB, K, MO, PERTH); 5 km N of Kwornicup Road on Sidcup Road, *K. Hill 2447* ♀, *2448* ♂, *L. Johnson and D. Blaxell*, 13 Nov 1986 (NSW); Golf Link Road, 5 km SE of Mt Barker, *A.R. Annels 4182*, 16 November 1993 ♀ (PERTH); 45 km N of Albany on Borden road, *B. Briggs 6618* ♂, 5 Oct 1976 (NSW, PERTH), *6617* ♀ (NSW); 13.5 km ENE of Manypeaks on S Coast Highway, *B. Briggs 7652a and L. Johnson*, 8 Oct 1984 ♀ (NSW, CANB, PERTH, RSA); King Georges Sound, *J. H. Maiden NSW65875,* Nov 1902 ♀ (NSW); Gnowellen road, 14.5 km NW of Chillinup road junction, due E of Ellen Peak (Stirling Range), *B. Briggs 7908 and L. Johnson*, 11 Oct 1984 ♀ (NSW, CANB, PERTH, PRE); Stirling Range National Park, in stream near Chester Pass road at S end of Park, *S. Carlquist 5699*, 20 Sep 1974 (RSA); 0.5 km E of Albany–Borden road, on road to South Stirling, *B. Briggs 6627*, 5 Oct 1976 ♂ (NSW, K); 3 km SE of intersection of Mason Bay Road and Middle Road, 15 km SW of Jerdacuttup, *M.N. Lyons and S.D. Lyons 4736*, 13 December 2000 (PERTH).

Leptocarpus thysananthus B.G.Briggs, **sp. nov.**

'Meeboldina thysanantha B.G.Briggs & L.A.S.Johnson, unpubl.', Briggs and Johnson (1999), Meney et al. (1999), Paczkowska and Chapman (2000), Wheeler et al. (2002); *Meeboldina* sp. F, Briggs et al. (2014).

Diagnosis: Plants forming large dense tussocks to 1.8 m tall with stout woody rhizomes, 7–10 mm diam.; male spikelets small, 3–5(–9) mm long, glumes not glossy, with margin hyaline; female inflorescence with aristate glumes; female flowers cylindrical; tepal margins densely fimbriate.

Type: Western Australia: Kenton, E of Walpole, South Coast Highway at Kent River, 17 Sep 1966, *B.G. Briggs 634* ♀ (holo: NSW95209; iso: MEL600565A, PERTH8371660).

Plants forming large dense tussocks to 1.8 m tall and 1 m across with hard woody interlacing rhizomes, resprouting after fire. *Rhizome* elongated, stout, 7–10 mm diam., cataphylls brown, covering a pale to brown woolly pubescence. *Culms* usually spaced to c. 1 cm apart, simple below the inflorescence, terete, 2.5–4 mm diam. near base, 1–1.8 m long, sub-striate, grey-green. *Culm sheaths* 1–2 cm long, striate, pale-brown, lamina erect, usually 3–8 mm long; membranous margin weathering away, c. 3 mm wide. *Inflorescence* long, narrow, erect, c. 20–100 cm long; male spikelets ± erect and loosely clustered in the upper 5–10 cm of each branch, branches arising from the upper 10–15 nodes of the culm and the more distal branches often repeatedly

branched; the female inflorescence similar to the male but usually with fewer branches. *Male spikelets* pedicellate, with pedicels filiform, up to c. 1 cm long; spikelets ovoid, 3–5(–9) mm long, up to c. 10(–18) glumes, all fertile; glumes ovate, chestnut-brown, glabrous, aristate, 1.2–2.5 mm long with hyaline membranous margins; mucro erect, to c. 0.5 mm long. *Female spikelets*: 1–several crowded on each of many short (0.5–2 cm) final branches; glumes narrow-lanceolate to ovate, red-brown, acute to aristate, 1–4 mm long; awn erect, to c. 0.5 mm long *Male flowers*: tepals 5–6, acutely acuminate, brown-hyaline, glabrous; outer tepals keeled, lanceolate, 1–1.6 mm long; inner tepals concave, ovate, slightly longer; stamens 3; filaments 0.2–0.4 mm long; anthers 0.5–1 mm long; pistillode absent. *Female flowers*: bracts 2, narrow-lanceolate, glabrous, shorter and broader than tepals; tepals 6, narrow-lanceolate, acute, membranous, 1–1.5 mm long; outer tepals keeled; inner tepals flat, margins densely fimbriate; style 3-branched, filiform, mostly stigmatic. *Nut* trigonous, 0.7–1.1 mm long, brown. Chromosome number $2n = 24$. (Fig. 11 g–l)

The epithet refers to the fimbriate margin of the tepals of female flowers; from the Greek *thysanos* = fringe or tassel and *anthos* = flower.

Distribution: Western Australia: Swan Coastal Plain, Jarrah Forest and Warren regions: from near Collie and Busselton to Albany. On sand or clayey soil, sometimes with laterite gravel, in moist sites and on river banks; in eucalypt forest or woodland, or (less often) in *Melaleuca*-swamps or sedge-swamps. Map: Fig. 13.

Conservation status: Widespread and common.

Note: The stout woody rhizomes and large size of plants are distinctive, as are the small male and female spikelets; females with aristate glumes and tepals. Differs from *L. coangustatus* in the generally thicker rhizomes; stouter and taller culms; male spikelets cylindrical or ± cuneate with spreading glumes, not glossy; female flowers cylindrical with linear-lanceolate tepals. *Leptocarpus coangustatus* has culms 0.4–0.8 m tall; male spikelets ovoid, glossy, 4–6 mm long; female spathes and glumes with more clearly defined hyaline margins; female flowers ovoid.

Selected specimens examined: Hamilton River, 10 km WNW of Collie on road to Roelands, *B. Briggs 6700A* ♂ 10 Oct 1976 (NSW, AD, CANB, PERTH), *6701* ♀ (NSW, AD, MEL, PERTH); Carbunup River at Roy Road bridge, c. 2 km S of Jindong, *B.G. Briggs 8330 and L. Johnson*, 26 Oct 1988 ♂ (NSW); Cowaramup, *R.D. Royce 2823*, 15 Oct 1948 ♀ (PERTH); Albany Highway between Kojonup and Beaufort River, *K. Meney and J. Pate*, Apr 1992 ♀ (NSW); Barlee Brook at Stewart Road, c. 34 km SSE of Nannup, *B.G. Briggs 7599 and L. Johnson,* 6 Oct 1984 ♀ (NSW, BOL, CANB, K, MO, PERTH, RSA); Pemberton, *M. Koch 2662,* Feb 1920 ♂, ♀ (NSW); 1.8 km N along Carter Road from intersection with Donnelly Mill Road, *C. Day and T. Annels MJ 6.2*, 17 February 1997 (PERTH); Tom Road at Donnelly River Crossing, *M. Hislop 1203B*, 10 Nov 1998 (PERTH, NSW); 6 miles [10 km] from Rocky Gully towards Manjimup, *Chessell and McComb 138*, 26 August 1965 ♀ (PERTH); South Coast Highway W of Denmark, 0.8 km E of Parker Road, *B.G. Briggs 9974,* 26 Oct 2008 ♂ (NSW, K, MO, NY, PERTH); Kenton, c. 20 miles [30 km] W of Denmark, *B. Briggs 633*, 17 Sep 1966 ♂ (NSW, HO, MEL, PERTH), *634* ♀ (NSW, BRI, HO, MEL, PERTH); Bow River, S. *Jackson*, Dec 1912 (PERTH, NSW); South Coast Highway, 0.5 km W of William Bay Road, *B.G. Briggs 10073* ♂, *10074* ♀, 5 Nov 2010 (NSW, BRI, CANB, K, MO, PERTH); 3.5 miles [5 km] SW of Denmark, *B. Briggs 624*, 17 Sep 1966 ♂ (NSW, CANB), *623* ♀ (NSW); South Coast Highway, 0.8 km E of Parker Road, *B.G. Briggs 9972*, 26 Oct 2008 ♀ (NSW, MO, PERTH).

Acknowledgments

I acknowledge the major contribution of the late L.A.S. (Lawrie) Johnson (formerly at NSW) to this study and to distinguishing the species described here. I also acknowledge the critical importance of insights into relationships among these taxa from DNA data obtained by Adam Marchant and analyses by Andrew Perkins (both then NSW). The drawings are by Lesley Elkan, the diagram by Debby McGerty, and Julia Sideris assisted with the maps (all NSW). Technical help by Carolyn Porter (NSW) and Siegfried Krauss (KPBG, formerly NSW) made large contributions to this work. Many others have assisted these Restionaceae studies over the years, including Louisa Murray, Barbara Wiecek, Robert Makinson, Anna-Louise Quirico and Vivian Shanker (all NSW). Excellent scans of the type specimen of *Leptocarpus canus* were provided by Gina Murrell and Christine Bartram of Cambridge University Herbarium (CGE). Field studies and discussions with Eleanor Bennett, Kevin Thiele, Chris Hollister (all PERTH), Kathy Meney (KPBG) and John Pate (University of Western Australia) contributed importantly.

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Mansucript received 9 December 2013, manuscript accepted 19 March 2014