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Review

Understanding Diversity and Systematics in Australian Fabaceae Tribe Mirbelieae

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Abstract: Australia has a very diverse pea-flowered legume flora with 1715 native and naturalised species currently recognised. Tribe Mirbelieae s.l. includes 44% of Australia's peas in 24 genera with 756 recognised species. However, several genera within the *Pultenaea* alliance in tribe Mirbelieae are considered to be non-monophyletic and two main options have been proposed: option one is to merge ca. 18 genera containing ca. 540 species (the largest genus, *Pultenaea* has nomenclatural priority); and option two is to re-circumscribe some genera and describe new genera as required to form monophyletic groups. At the species level, option one would require 76% of names to be changed; whereas based on available data, option two is likely to require, at most, 8.3% of names to change. Option two therefore provides the least nomenclatural disruption but cannot be implemented without a robust phylogenetic framework to define new generic limits. Here we present novel analyses of available plastid DNA data (*trn*L-F) which suggest that option two would be feasible once sufficient data are generated to resolve relationships. However, the reticulate evolutionary histories or past rapid speciation suggested for this group may prevent the resolution of all nodes. We propose targeted use of Next-Generation Sequencing technology as the best way to resolve relationships between the key clades in the tribe and present a framework for such a study. An overview of current taxonomy in the tribe is presented, along with the state of taxonomic knowledge and availability of published descriptions for electronic flora treatments. Several new combinations and typifications are published in an appendix.

Keywords: phylogeny; diversification; taxonomy; legumes; biogeography; nomenclature; typification; new combinations

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1. Introduction

Legumes (Family Fabaceae/Leguminosae) are the third largest plant family behind daisies (Asteraceae) and orchids (Orchidaceae) and the family contains an incredible range of morphological and ecological diversity [1]. Legumes date back to the Maastrichtian or early Paleocene, diversifying after the Cretaceous–Paleogene boundary mass extinction event [2]. Estimating the phylogeny and establishing a useful classification system is naturally a challenging task in such a diverse lineage, however significant advances have been achieved in recent decades, particularly through contributions to the series *Advances in Legume Systematics* [3–14]. Hundreds of publications have addressed the relationships between particular clades of Fabaceae using phylogenetic data, and a number of important consensus publications have drawn these data together [15–28]. Broad sampling of genomic sequence data is now resolving many previously intractable nodes, particularly related to those nodes that appeared early in the evolution of legumes [29,30], though it appears that some nodes may be unresolvable regardless [31]. Despite all of these efforts, there are still many unresolved relationships across the family [25].

Australia's legume flora of over 3000 species is dominated by the iconic genus *Acacia* Mill., with ca. 1100 species [32]. The next largest taxonomic group in Australian legumes is the Faboideae tribe Mirbelieae, with 24 currently accepted genera and 756 recognised species. The tribe is essentially endemic to Australia, with just a single species (*Gomphlobium nitidum* Sol. ex Benth.) extending north to Papua New Guinea [33]. Species within the tribe are distributed across the entire continent, occupying habitats from coastal to alpine zones, and wet forests to arid deserts. They reach their highest diversity in the Southwest Botanical Province, a biodiversity hotspot, with a secondary centre of diversity in southeastern Australia [34]. Two species, *Callistachys lanceolata* Vent. and *Pultenaea daphnoides* J.C. Wendl., have become naturalised in New Zealand. So far, no taxa in Mirbelieae are known to have naturalised in South Africa, despite climatic similarities and other Australian legumes becoming invasive species there [35].

Orthia et al. [34,36] highlighted the lack of phylogenetic resolution and conflicts between the available data and existing taxonomic classifications in tribe Mirbelieae, however, little has been published on the topic since. As these papers were published over 15 years ago, and little progress has been made since, it is considered timely to review available data and provide a roadmap for the resolution of both phylogenetic and taxonomic problems in the tribe. We here combine the available *trn*L-LF data in a novel analysis as a framework for discussing known issues and proposing a framework for future work. While most potential nomenclatural changes must await the generation of more informative molecular data, a few nomenclatural changes are justified by existing data and these are made in the current paper. The application of several names is also clarified through typification to reduce the number of names of uncertain application in public databases.

1.1. Tribal Limits

Tribe Mirbelieae has been recognised as a natural group for four decades [37], sharing with the closely related tribe Bossiaeeae an endemic distribution in Australia and distinctive yellow and red corolla markings, hence the common name "egg-and-bacon" peas. Earlier classifications relied on morphology-based analyses to assess the relationships of genera in the Mirbelieae (Table 1; [37–41]). Subsequent studies used DNA sequences to estimate the phylogeny and interpreted the morphology from its fit to the molecular trees. A molecular phylogenetic framework for understanding taxonomic limits of the tribes has only partially been developed [34,36,42–48]. Both chloroplast DNA sequences (especially *trn*L-F) and nuclear ribosomal DNA (mainly ITS) have been used and are often combined for analysis—except when conflicting (e.g., [34,48]). Molecular studies have consistently found both Bossiaeeae and core Mirbelieae to be monophyletic. These groups differ in embryology [49]. A clade comprising core Mirbelieae plus *Isotropis* Benth. shares reduced, 5-nucleate female gametophytes as a synapomorphy, while Bossiaeeae share normal 8-nucleate megametophytes but with giant antipodals. The other genera of Mirbelieae s.l., including *Daviesia* Sm., *Gompholobium* Sm., *Sphaerolobium* Sm., *Erichsenia* Hemsl. and *Viminaria* Sm., have giant antipodals. Relationships among the genera of the giant antipodals group (including Bossiaeeae) have varied among analyses, and also between the genomes [46,48]. This group has usually been found to be non-monophyletic with core Mirbelieae nested inside. However, in the ITS partition, a base-composition bias (non-stationarity) between groups with the two embryological traits may explain the non-monophyly [46]. When stationarity was partially corrected by using a Logdet model in a neighbour-joining analysis, the giant antipodals group was found to be monophyletic, though without branch support [46]. That is, the two embryological groups were reciprocally monophyletic. As monophyly of core

Mirbelieae has been consistently supported, this tribe could be restricted to the 5-nucleate embryo-sac group. Then, Bossiaeeae could be expanded to include all the genera with giant antipodals (i.e., *Daviesia*, *Gompholobium*, etc). Another possibility would be to combine Bossiaeeae and Mirbelieae into a single tribe. In this case, the name Bossiaeeae would have priority over Mirbelieae. However, reclassification of the tribal boundaries of the egg and bacon peas is premature until phylogenetic relationships of the genera are better understood (Table 1).

Table 1. Genera of Mirbelieae s.l. (column 1); previously published suprageneric classifications (columns 2 and 3); embryo-sac groups (column 4); usage in the present review; columns 5 and 6 indicate whether genera are monophyletic (yes/no/–) in published phylogenies with separate cpDNA and ITS trees [36,46–48].

Genus	Polhill [37]	Genus Group [46]	Embryo-Sac [46]	Current Paper	Monophyletic cpDNA	Monophyletic ITS
Jacksonia	Mirbelieae	*Mirbelia* group	5-nucleate	Core Mirbelieae	yes	yes
Leptosema	"	"	"	"	yes	yes
Latrobea	"	"	"	"	yes	yes
Chorizema	"	"	"	"	no	no
Oxylobium	"	"	"	"	no	no
Mirbelia	"	"	"	"	no	no
Callistachys	"	"	"	"	–	–
Aotus	"	"	"	"	no	no
Otion	"	"	"	"	–	–
Urodon	"	"	"	"	–	–
Phyllota	"	"	"	"	yes	yes
Euchilopsis	"	"	"	"	–	–
Dillwynia	"	"	"	"	no	no
Eutaxia	"	"	"	"	yes	no
Almaleea	"	"	"	"	–	–
Stonesiella	"	"	"	"	–	–
Pultenaea	"	"	"	"	no	no
Podolobium	"	"	"	"	no	no
Gastrolobium	"	"	"	"	yes *	yes *
Isotropis	"	*Isotropis*	"	Mirbelieae s.l.	yes	yes
Erichsenia	"	*Daviesia* group	giant antipodals	"	–	–
Viminaria	"	"	"	"	–	–
Daviesia	"	"	"	"	yes	yes
Sphaerolobium	"	"	"	"	yes	yes
Gompholobium	"	"	"	"	no	no
Bossiaea	Bossiaeeae	Bossiaeeae	"	Bossiaeeae	no	no
Platylobium	"	"	"	"	yes	yes
Goodia	"	"	"	"	yes	yes
Aenictophyton	"	"	"	"	–	–
Muelleranthus	"	"	"	"	–	–
Ptychosema	"	"	"	"	–	–
Paragoodia	"	"	"	"	–	–

*: *Gastrolobium* sensu Chandler et al. [50]. " indicates 'as above'. '–': multiple species in genus but only one sampled (or genus monotypic).

1.2. Genus-Level Questions

Most recognised genera in Mirbelieae were established in the first half of the 19th Century [50–67]. Despite most genera being established for so long, generic boundaries within core Mirbelieae remain contentious because published phylogenies do not resolve a number of these genera as monophyletic [34,36,68] (Table 1). Orthia et al. [34,36] suggested that the evolutionary history of the core Mirbelieae may be complex, with potential for ancestral polymorphism, hybridisation, and incomplete speciation/incomplete lineage sorting. Data also suggest a recent radiation of extant taxa and all of these factors are potentially resulting in a lack of resolution and statistical support for the major clade relationships in the tribe. A rapid radiation during the tertiary has been suggested for many legume groups [22]. Interpretation of phylogenetic histories should take these factors into account. However, little is known of the presence or frequency of polyploidization or apomixis in the tribe. Likewise, there is insufficient data to infer any consistency of maternal inheritance of the chloroplast genome among these genera.

Phylogenetic analyses from the Cook and Crisp labs [69–71] used both nuclear ITS data and chloroplast data, including but not necessarily restricted to *trn*L-F. Trees estimated from the separate genomes were generally congruent and therefore results from analyses of combined data were used. However, in an analysis of *Pultenaea* s.l. [34], the chloroplast and nuclear trees were in conflict and the results were presented separately. Species-level sampling is still insufficient to resolve a number of generic boundaries, and several key nodes in the backbone of the *trn*L-F phylogeny remain unsupported. Some additional data are available for other markers, including ITS, ETS, *trn*K, *mat*K, *psb*A-*trn*H and *trn*L, but sampling density is relatively low. However, these results do provide support for many clades, including *Gastrolobium* R.Br., *Jacksonia* R.Br. ex Sm., *Mirbelia* Sm., core *Oxylobium* Andrews, and core *Pultenaea*, which contain most species in the core tribe. The resolution of these key clades as monophyletic provides a high degree of confidence that alternate classifications can be devised to minimise nomenclatural change once data are generated that can provide sufficient phylogenetic resolution in order to flesh out the backbone of the phylogeny. The current lack of resolution means that the best outcome for taxonomic stability (lumping or dividing existing genera) is uncertain.

One proposed solution is to include all genera in the *Pultenaea* alliance in a greatly enlarged mega-genus *Pultenaea* [34], but this has been met with little enthusiasm from the botanical community and general public. However, an alternative solution is not available currently, and cannot be obtained without significant new molecular data. If additional data are generated that resolve relationships, then it is likely that *Aotus* Sm., *Eutaxia* R.Br., *Podolobium* R.Br. and *Pultenaea* will require significant re-circumscription. Minor adjustments are likely to be required in *Callistachys* Vent., *Chorizema* Labill. (potentially to include *Podolobium* s.s.), *Oxylobium* and *Phyllota* (DC.) DC. ex Benth. Several new genera are likely to be required in order to define monophyletic genera within the tribe, however this option may require less nomenclatural change than the creation of a giant *Pultenaea* including ca. 540 species.

1.3. Species-Level Questions

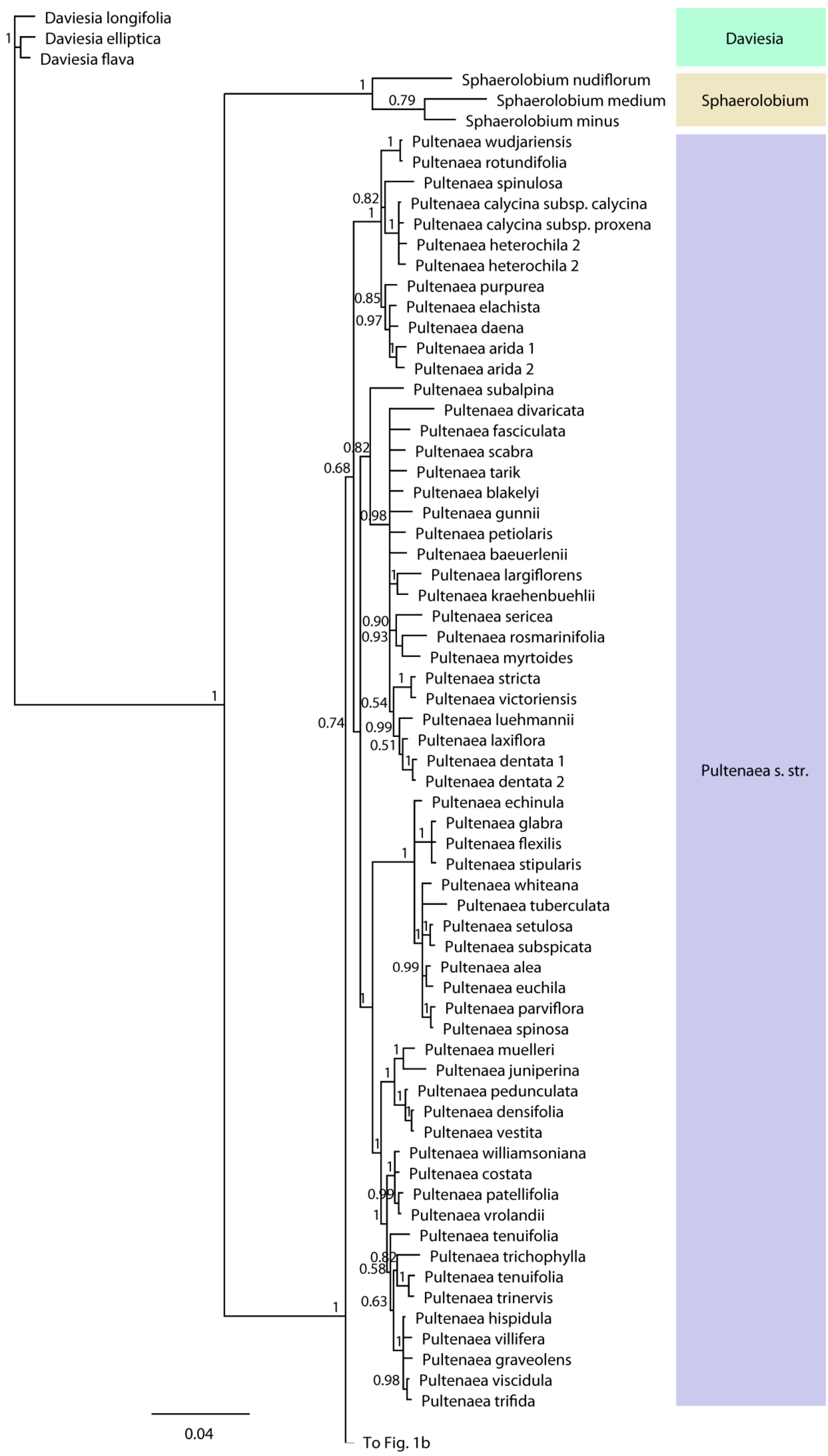
A significant amount of work has been undertaken to resolve the taxonomic issues within most genera of tribe Mirbelieae. Full taxonomic revisions have been completed for *Almaleea* Crisp & P.H. Weston [72], *Chorizema* [73], *Daviesia* [69,74–82], *Erichsenia* [83], *Gastrolobium* R.Br. [44,71,84–86], *Gompholobium* Sm. [87–89], *Jacksonia* [90], *Leptosema* Benth. [91], *Phyllota* [92], *Pultenaea* [93–97], and *Stonesiella* Crisp & P.H. Weston [42]. Partial revisions have been completed for *Aotus* [98], *Eutaxia* [99,100], *Latrobea* Meisn. [101], *Mirbelia* Sm. [102,103] and *Sphaerolobium* [104–110].

Some genera such as *Isotropis* are being worked on progressively, with species complexes or distinctive entities being named as they are resolved [111–116]. Revisionary work is in progress for the complex genus *Dillwynia* Sm. [117,118], and four new combinations are provided in Appendix A of this paper, building on three new species published by Jobson and Weston [119,120]. Regional flora treatments, including tribe Mirbelieae, are available for many taxa in the genera mentioned above and all or most species of *Callistachys* Vent., *Euchilopsis* F. Muell., *Oxylobium* Andrews, *Urodon* Turcz. and *Viminaria*, though several of these genera still require systematic revision [111,118,121–138]. New putative species are still being identified on a regular basis in Australia, and many of these new discoveries are localised taxa that warrant conservation listing.

Despite relatively recent revisions [93–97], morphological assessments of *Pultenaea* s.s. have identified many species circumscriptions that remain uncertain (R.L. Barrett, J.A.R. Clugston & M.A.M. Renner, unpubl. data). There are also unresolved issues of typification, as not all relevant material was located during these revisions (R.L. Barrett, unpubl. data) We estimate that around a third of the 148 species currently included in *Pultenaea* should have their taxonomic circumscriptions revised. Many changes differing from these treatments have already been adopted by the Flora of South Australia [124] and VicFlora [139]. Detailed assessment of the *Pultenaea glabra* Benth. complex by M.A.M. Renner et al. (in prep.), has identified six new species. As *Pultenaea glabra* is already listed as rare in its broadest circumscription, all of the segregate species are likely to be listed as threatened taxa within New South Wales. It is likely that many additional taxa that are of conservation priority should be recognised in *Pultenaea*.

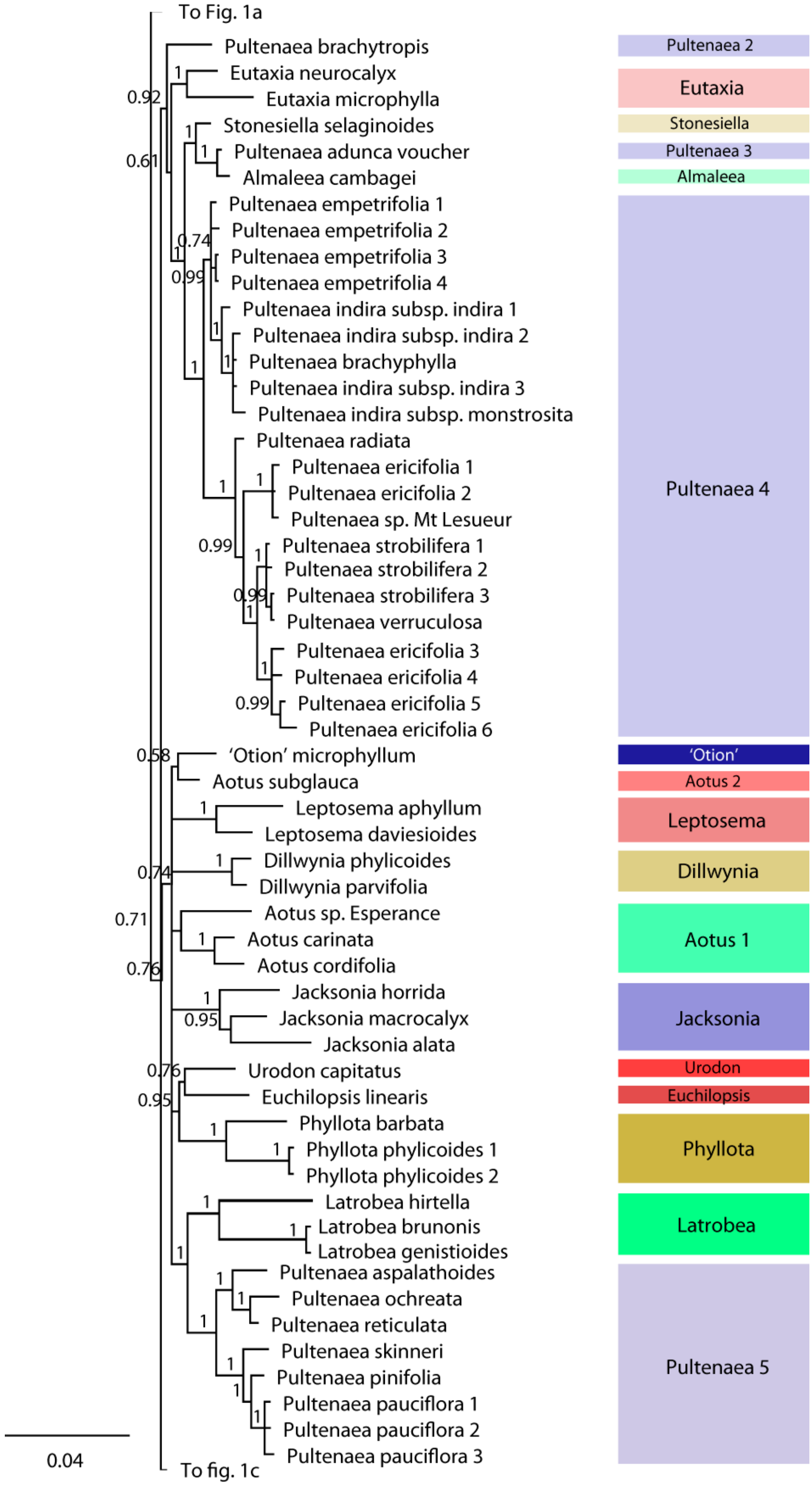
1.4. Biogeographic Patterns

Tribe Mirbelieae is of significant interest for understanding the evolution of the Australian flora due to its distribution across Australia, high species diversity [68,140], high levels of local endemism [71,141–143], morphological diversity [46], breeding systems [144], and specialised pollination syndromes [48,145]. There are contrasting centres of endemism in both southwestern (particularly *Daviesia* and *Gastrolobium*) and southeastern Australia (particularly *Bossiaea*, *Dillwynia* and *Pultenaea*), a pattern not seen in many species-rich groups in Australia [40,146,147]. These parallel patterns offer unique opportunities for understanding broader patterns and processes of speciation in the two regions. These strong biogeographic trends are reflected in phylogenetic reconstructions of the tribe (Figure 1). A comparison of south-west and south-east diversity patterns in *Daviesia* and *Bossiaea* [70] revealed that the geographic overlap of clades was significantly greater for *Daviesia* in the south-west than in the south-east but that this was reversed for *Bossiaea*. Despite this, diversification rates did not differ between the regions in either genus over the last 10 Myr [70]. Rather, the interaction of multiple factors likely explains the diversity differences between the two regions. The smaller south-western geographic ranges of species in both genera are probably explained by the steeper climatic gradients in that region. *Daviesia* is far more species-rich in the south-west than in the south-east, likely because of its longer evolutionary time there, combined with the greater geographic overlap of clades [70].



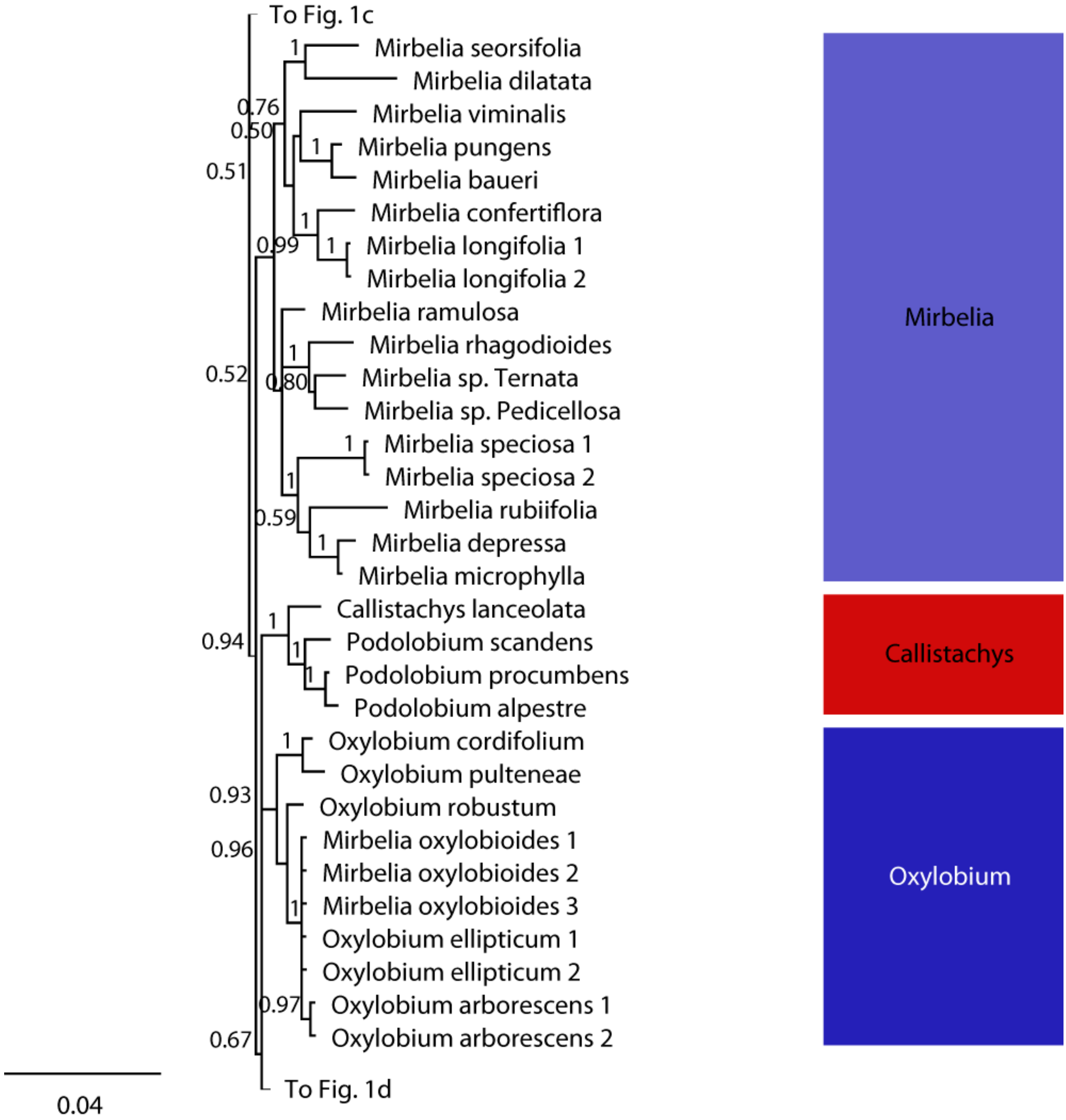
(**A**)

Figure 1. *Cont*.



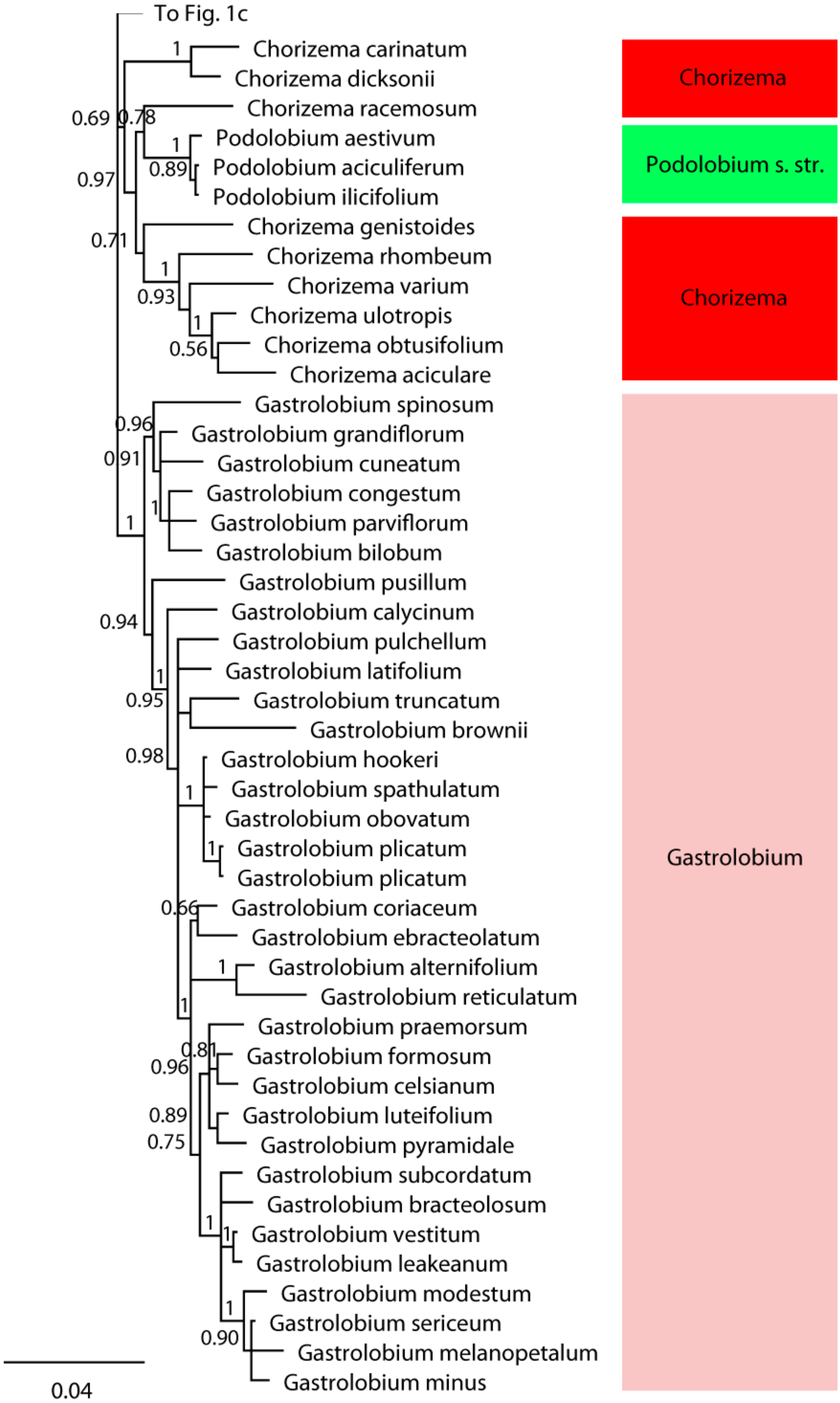
(**B**)

Figure 1. *Cont.*



(C)

Figure 1. *Cont.*



(**D**)

Figure 1. (**A**–**D**) Phylogeny of Fabaceae tribe Mirbelieae inferred from *trn*L intron and *trn*L–F spacer (cpDNA). Posterior output from MrBayes. Numbers above lines are posterior probability.

2. Materials and Methods

Phylogenetic Analyses

A phylogeny of core Mirbelieae has been inferred here using the *trn*L intron and *trn*L–F spacer of cpDNA. Previous studies have only included selected data, so a novel analysis is justified in order to assess all of the available data for this marker. All available sequences for tribe Mirbelieae were downloaded from NCBI Genbank (Table 2). As genera outside core Mirbelieae are relatively distantly related [46], and the key questions we wish to address relate to core Mirbelieae, only six species outside this core were included as outgroups (Table 2). Randomly selected sequences were checked by using BLAST (http://blast.ncbi.nlm.nih.gov/Blast.cgi (accessed on 25 April 2021)) to ensure that they were not from a contaminated source. A preliminary alignment was performed using MAFFT ver. 7.450 [148,149] and minor corrections were made manually with Geneious Prime (ver. 2021.1.1, see https://www.geneious.com, accessed on 25 April 2021). Phylogenetic analyses were performed using Bayesian inference implemented in MrBayes (ver. 3.2.6, see https://github.com/NBISweden/MrBayes/releases/tag/v3.2.6 (accessed on 25 April 2021)) [147,148]. *Daviesia longifolia* Benth. was designated as the outgroup for analyses. Four Markov-Chain Monte Carlo (MCMC) chains were run for 20 million generations, with one tree sampled every 5000 generations at a temperature of 0.2 with default priors (gamma), and GTR substitution model, GTR+I+G (identified by the Akaike Information Criterion corrected for small sample sizes in jModelTest2; https://github.com/ddarriba/jmodeltest2 (accessed on 30 June 2021)). The first 2,000,000 trees recovered were discarded as burn-in (trees produced before convergence). Stationarity and mixing were assessed using Tracer (ver. 1.7.1) [150].

Table 2. Taxa analysed, vouchers and GenBank reference numbers for the *trn*L intron and *trn*L–F spacer. Herbarium codes for voucher location follow Thiers (2008 onwards; http://sweetgum.nybg.org/science/ih/ (accessed on 25 April 2021)).

Taxon	Collector	Number	Herbarium	GenBank
Almaleea Crisp & P.H.Weston				
A. cambagei (Maiden & E.Betche) Crisp & P.H.Weston	M.D. Crisp	9197	CANB	AF113775
Aotus Sm.				
A. carinata Meisn.	J.A. Chappill	6581	PERTH	AY883181
A. cordifolia Benth.	J.A. Chappill	6587	PERTH	AY883182
A. sp. Esperance (P.G. Wilson 7904)	M.D. Crisp	9197	CANB	AF518163
A. subglauca Blakey & McKie	M.D. Crisp	9047	CANB	AF113776
Callistachys Vent.				
C. lanceolata Vent.	G.T. Chandler	474	CANB	AY015072
Chorizema Labill.				
C. aciculare (DC.) C.A.Gardner	M.D. Crisp	9202	CANB	AF518149
C. carinatum (Meisn.) J.M.Taylor & Crisp	M.D. Crisp	9237	CANB	AF518150
C. dicksonii Graham	M.D. Crisp	9166	CANB	AY251250
C. genistoides (Meisn.) C.A.Gardner	M.D. Crisp	9026	CANB	AF518151
C. obtusifolium (Sweet) J.M.Taylor & Crisp	M.D. Crisp	9201	CANB	AY251251
C. parviflorum Benth.	M.D. Crisp	9166	CANB	AF518152
C. rhombeum R.Br.	M.D. Crisp	9230	CANB	AF518153
C. ulotropis J.M.Taylor & Crisp	M.D. Crisp	9214	CANB	AY251253
C. varium Benth.	M.D. Crisp	8528	CANB	AF518154
Dillwynia Sm.				
D. parvifolia R.Br. ex Sims	J.M. Taylor	360	CBG	AF113777
D. phylicoides A.Cunn.	M.D. Crisp	9049	CANB	AF113778
Euchilopsis F.Muell.				
E. linearis (Benth.) F.Muell.	M.D. Crisp	8535	CANB	AF113779
Eutaxia R.Br.				

Table 2. *Cont.*

Taxon	Collector	Number	Herbarium	GenBank
C. racemosum (Meisn.) J.M.Taylor & Crisp	M.D. Crisp	9012	CANB	AY251252
E. microphylla (R.Br.) C.H.Wright & Dewar	M.D. Crisp	8918	CANB	AF113780
E. neurocalvx (Turcz.) Chappill & G.R.Hend.	M.D. Crisp	8525	CANB	AF113789
Gastrolobium R.Br.				
G. alternifolium G.Chandler & Crisp	M.D. Crisp	8512	CANB	AY015088
G. bilobum R.Br.	G.T. Chandler	724	CANB	AY015073
G. bracteolosum (F.Muell.) G.Chandler & Crisp	G.T. Chandler	426	CANB	AY015063
G. brownii Meisn.	G.T. Chandler	726	CANB	AY015074
G. calycinum Benth.	G.T. Chandler	544	CANB	AY015075
G. celsianum (Lem.) G.Chandler & Crisp	M.D. Crisp	9009	CANB	AY015064
G. congestum G.Chandler & Crisp	G.T. Chandler	404	CANB	AY015076
G. coriaceum (Sm.) G.Chandler & Crisp	G.T. Chandler	723	CANB	AY015089
G. cuneatum Henfr.	M.D. Crisp	8937	CANB	AY015077
G. ebracteolatum G.Chandler & Crisp	M.D. Crisp	8471	CANB	AY015102
G. formosum (Kippist ex Lindl.) G.Chandler & Crisp	M.D. Crisp	8933	CANB	AY015085
G. grandiflorum F.Muell.	G.T. Chandler	598	CANB	AY015078
G. hookeri Meisn.	M.D. Crisp	8907	CANB	AY015090
G. latifolium (R.Br.) G.Chandler & Crisp	G.T. Chandler	365	CANB	AY015065
G. leakeanum J.Drumm.	M.D. Crisp	8481	CANB	AY015091
G. luteifolium (Domin) G.Chandler & Crisp	M.D. Crisp	9407	CANB	AY015092
G. melanopetalum (F.Muell.) G.Chandler & Crisp	M.D. Crisp	8470	CANB	AY015066
G. minus (Crisp) G.Chandler & Crisp	M.D. Crisp	8922	CANB	AY015067
G. modestum (Crisp) G.Chandler & Crisp	M.D. Crisp	8465	CANB	AY015068
G. obovatum Benth.	G.T. Chandler	657	CANB	AY015093
G. parviflorum (Benth. ex Lindl.) Crisp	G.T. Chandler	760	CANB	AY015079
G. plicatum Turcz. 1	G.T. Chandler	623	CANB	AY015094
G. plicatum Turcz. 2	M.D. Crisp	9014	CANB	AF518161
G. praemorsum (Meisn.) G.Chandler & Crisp	G.T. Chandler	729	CANB	AY015069
G. pulchellum Turcz.	M.D. Crisp	8480	CANB	AY015095
G. pusillum Crisp & P.H.Weston	M.D. Crisp	8921	CANB	AY015080
G. pyramidale T.Moore	G.T. Chandler	488	CANB	AY015096
G. reticulatum (Meisn.) Benth.	G.T. Chandler	540	CANB	AY015097
G. sericeum (Sm.) G.Chandler & Crisp	J.M. Taylor	1959	CBG	AY015070
G. spathulatum Benth. ex Lindl.	M.D. Crisp	8448	CANB	AY015098
G. spinosum Benth. ex Lindl.	G.T. Chandler	548	CANB	AY015081
G. subcordatum (Benth.) G.Chandler & Crisp	M.D. Crisp	8511	CANB	AY015071
G. truncatum Benth.	M.D. Crisp	8919	CANB	AY015082
G. vestitum (Domin) G.Chandler & Crisp	M.D. Crisp	8489	CANB	AY015099
Jacksonia Sm.				
J. alata Benth.	M.D. Crisp	8956	CANB	AF518146
J. horrida DC.	M.D. Crisp	8934	CANB	AY015084
J. macrocalyx Meisn.	M.D. Crisp	9272	CANB	AF518147
Latrobea Meisn.				
L. brunonis (Benth.) Meisn.	J.A. Chappill	6564	PERTH	AY883186
L. genistoides (Meisn.) Meisn.	J.A. Chappill	6567	PERTH	AY883187
L. hirtella (Turcz.) Benth.	M.D. Crisp	8478	CANB	AF113781
Leptosema Benth.				
L. aphyllum (Hook.) Crisp	M.D. Crisp	9019	CANB	AF518148
L. daviesioides (Turcz.) Crisp	M.D. Crisp	9193	CANB	AY883188
Mirbelia Sm.				
M. baueri (Benth.) Joy Thomps.	M.D. Crisp	9144	CANB	AY251254
M. confertiflora Pedley	M.D. Crisp	9050	CANB	AF518155
M. depressa E.Pritz.	M.D. Crisp	9020	CANB	AY015086
M. dilatata R.Br.	M.D. Crisp	8491	CANB	AY015087
M. longifolia C.A.Gardner 1	M.D. Crisp	9263	CANB	AY883189

Table 2. *Cont.*

Taxon	Collector	Number	Herbarium	GenBank
M. longifolia C.A.Gardner 2	M.D. Crisp	9263	CANB	AY251255
M. microphylla (Turcz.) Benth.	A. Monro	22	CANB	AF518156
M. oxylobioides F.Muell. 1	M.D. Crisp	9112	CANB	AY251264
M. oxylobioides F.Muell. 2	Yi	14,825	KUN	NC_047371
M. oxylobioides F.Muell. 3	Yi	14,825	KUN	MN709855
M. pungens A.Cunn. ex G.Don.	M.D. Crisp	9138	CANB	AY251257
M. ramulosa (Benth.) C.A.Gardner	A. Monro	4	CANB	AY251258
M. rhagodioides Crisp & J.M.Taylor	M.D. Crisp	9259	CANB	AY251259
M. rubiifolia (Andrews) G.Don	ANBG	8406509	CANB	AF518157
M. seorsifolia (F.Muell.) C.A.Gardner	H. King	314	CANB	AY251260
M. sp. Pedicellosa (A.Monro 25)	A. Monro	25	CANB	AY251256
M. sp. Ternata (M.D.Crisp & L.G.Cook MDC 9267)	M.D. Crisp	9266	CANB	AY251262
M. speciosa Sieber ex DC. subsp. *speciosa* 1	M.D. Crisp	9123	CANB	AY251261
M. speciosa Sieber ex DC. subsp. *speciosa* 2	–	8100876	CBG	AF518158
M. viminalis (A.Cunn. ex Benth.) C.A.Gardner	D. Morris	547	CANB	AY251263
'***Otion***' Crisp & P.H.Weston ined.				
'*O. microphyllum*' (Benth.) Crisp & P.H.Weston ined.	M.D. Crisp	8970	CANB	AF113782
Oxylobium Andr.				
O. arborescens R.Br. 1	G.T. Chandler	616	CANB	AY015100
O. arborescens R.Br. 2	M.D. Crisp	9093	CANB	AF113783
O. cordifolium Andrews	M.D. Crisp	9133	CANB	AF518159
O. ellipticum (Vent.) R.Br. 1	M.D. Crisp	9092	CANB	AF113784
O. ellipticum (Vent.) R.Br. 2	G.T. Chandler	603	CANB	AY015101
O. lineare (Benth.) Benth.	M.D. Crisp	8471	CANB	AY015102
O. pulteneae DC.	M.D. Crisp	9046	CANB	AY015103
O. robustum Joy Thomps.	I.R. Telford	4294	CBG	AY015104
Phyllota (DC.) Benth.				
P. phylicoides (Sieber ex DC.) Benth. 1	M.D. Crisp	9048	CANB	AF113785
P. phylicoides (Sieber ex DC.) Benth. 2	M.R. Gillings	Soil core	–	JN392738
Podolobium R.Br.				
P. aciculiferum F.Muell.	G.T. Chandler	606	CANB	AF518160
P. aestivum Crisp & P.H.Weston	G.T. Chandler	612	CANB	AY015105
P. alpestre (F.Muell.) Crisp & P.H.Weston	G.T. Chandler	1039	CANB	AY015106
P. ilicifolium (Andrews) Crisp & P.H.Weston	G.T. Chandler	308	CANB	AY015107
P. procumbens (F.Muell.) Crisp & P.H.Weston	B. Hadlow	461	CBG	AY015108
P. scandens (Sm.) DC.	G.T. Chandler	309	CANB	AY015109
Pultenaea Sm.				
P. adunca Turcz.	J.A. Chappill	6544	PERTH	AY883190
P. alea de Kok	J. Westaway	924	CANB	AY883191
P. arida E.Pritz. 1	J.A. Chappill	6272	PERTH	AF518162
P. arida E.Pritz. 2	L.A. Orthia	71	CANB	AY883192
P. aspalathoides Meisn.	L.A. Orthia	50	CANB	AY883193
P. baeuerlenii F.Muell.	B. Pfeil	263	CANB	AY883194
P. barbata C.R.P.Andrews	T.R. Lally	1309	CANB	AY883195
P. phylicoides (Sieber ex DC.) Benth. 1	M.D. Crisp	9048	CANB	AF113785
P. phylicoides (Sieber ex DC.) Benth. 2	M.R. Gillings	Soil core	–	JN392738
Podolobium R.Br.				
P. aciculiferum F.Muell.	G.T. Chandler	606	CANB	AF518160
P. aestivum Crisp & P.H.Weston	G.T. Chandler	612	CANB	AY015105
P. alpestre (F.Muell.) Crisp & P.H.Weston	G.T. Chandler	1039	CANB	AY015106
P. ilicifolium (Andrews) Crisp & P.H.Weston	G.T. Chandler	308	CANB	AY015107
P. procumbens (F.Muell.) Crisp & P.H.Weston	B. Hadlow	461	CBG	AY015108
P. scandens (Sm.) DC.	G.T. Chandler	309	CANB	AY015109
Pultenaea Sm.				
P. adunca Turcz.	J.A. Chappill	6544	PERTH	AY883190
P. alea de Kok	J. Westaway	924	CANB	AY883191

Table 2. *Cont.*

Taxon	Collector	Number	Herbarium	GenBank
P. arida E.Pritz. 1	J.A. Chappill	6272	PERTH	AF518162
P. arida E.Pritz. 2	L.A. Orthia	71	CANB	AY883192
P. aspalathoides Meisn.	L.A. Orthia	50	CANB	AY883193
P. baeuerlenii F.Muell.	B. Pfeil	263	CANB	AY883194
P. barbata C.R.P.Andrews	T.R. Lally	1309	CANB	AY883195
P. blakelyi Joy Thomps.	R.P.J. de Kok	715	CANB	AY883196
P. brachyphylla Turcz.	L.A. Orthia	56	CANB	AY883197
P. brachytropis Benth.	L.A. Orthia	37	CANB	AY883198
P. calycina (Turcz.) Benth. subsp. *calycina*	L.A. Orthia	51	CANB	AY883199
P. calycina subsp. *proxena* Orthia & Chappill	L.A. Orthia	63	CANB	AY883199
P. costata H.B.Will.	R.P.J. de Kok	730	CANB	AY883200
P. daena Orthia	L.A. Orthia	57	CANB	AY883201
P. daphnoides J.C.Wendl.	E. Gauba	22,264	CBG	AF113786
P. densifolia F.Muell.	J. Mant	71	CANB	AY883202
P. dentata Labill.	M.D. Crisp	9053	CANB	AY015110
P. divaricata H.B.Will.	F.E. Davies	1887	CBG	AY883203
P. echinula Sieber ex DC.	R.P.J. de Kok	709	CANB	AY883204
P. elachista (F.Muell.) Crisp	L.A. Orthia	66	CANB	AY883205
P. empetrifolia Meisn. 1	L.A. Orthia	54	CANB	AY883206
P. empetrifolia Meisn. 2	L.A. Orthia	53	CANB	AY883385
P. empetrifolia Meisn. 3	L.A. Orthia	79	CANB	AY883386
P. empetrifolia Meisn. 4	L.A. Orthia	80	CANB	AY883387
P. ericifolia Benth. 1	L.A. Orthia	88	CANB	AY883207
P. ericifolia Benth. 2	L.A. Orthia	39	CANB	AY883388
P. ericifolia Benth. 3	L.A. Orthia	41	CANB	AY883389
P. ericifolia Benth. 4	L.A. Orthia	46	CANB	AY883390
P. ericifolia Benth. 5	L.A. Orthia	48	CANB	AY883391
P. ericifolia Benth. 6	M.D. Crisp	8451	CANB	AF113788
P. euchila DC.	D.A. Taylor	55	CANB	AY883208
P. fasciculata Benth.	R.P.J. de Kok	860	CANB	AY883209
P. flexilis Sm.	R.P.J. de Kok	705	CANB	AY883210
P. glabra Benth.	R.P.J. de Kok	cultivated	–	AY883211
P. graveolens Tate	R.P.J. de Kok	778	CANB	AY883212
P. gunnii Benth.	R.P.J. de Kok	900	CANB	AY883213
P. heterochila F.Muell. 1	J.A. Chappill	4279	PERTH	AY883231
P. heterochila F.Muell. 2	D.A. Taylor	1569	CANB	AY883401
P. hispidula Benth.	R.P.J. de Kok	780	CANB	AY883214
P. indira Orthia & Crisp subsp. *indira* 1	L.A. Orthia	59	CANB	AY883215
P. indira Orthia & Crisp subsp. *indira* 2	L.A. Orthia	70	CANB	AY883395
P. indira Orthia & Crisp subsp. *indira* 3	M.D. Crisp	9178	CANB	AY883396
P. indira subsp. *monstrosita* Orthia	L.A. Orthia	78	CANB	AY883397
P. juniperina Labill.	R.P.J. de Kok	713	CANB	AY883216
P. kraehenbuehlii P.J.Lang	R.J. Bayer	SA99010	CANB	AY883217
P. largiflorens F.Muell. ex Benth.	D.L.Jones	15,757	CANB	AY883218
P. laxiflora Benth.	A. Monro	64	CANB	AY883219
P. luehmannii Maiden	R.P.J. de Kok	738	CANB	AY883220
P. muelleri Benth.	R.P.J. de Kok	779	CANB	AY883221
P. myrtoides A.Cunn.	D.A. Taylor	7	CANB	AY883222
P. ochreata Meisn.	L.A. Orthia	42	CANB	AY883223
P. parviflora Sieber ex DC.	R.P.J. de Kok	793	CANB	AY883224
P. patellifolia H.B.Will.	R.P.J. de Kok	761	CANB	AY883225
P. pauciflora M.B.Scott 1	L.A. Orthia	83	CANB	AY883400
P. pauciflora M.B.Scott 2	L.A. Orthia	84	CANB	AY883226
P. pauciflora M.B.Scott 3	L.A. Orthia	85	CANB	AY883399
P. pedunculata Hook.	R.P.J. de Kok	756	CANB	AY883227
P. petiolaris A.Cunn. ex Benth.	R.P.J. de Kok	903	CANB	AY883228
P. pinifolia Meisn.	L.A. Orthia	40	CANB	AY883229
P. purpurea (Turcz.) Crisp & Orthia	L.A. Orthia	60	CANB	AY883230

Table 2. *Cont.*

Taxon	Collector	Number	Herbarium	GenBank
P. radiata H.B.Will.	L.A. Orthia	38	CANB	AY883232
P. reticulata (Sm.) Benth.	L.A. Orthia	47	CANB	AY883233
P. rosmarinifolia Lindl.	D.A. Taylor	68	CANB	AY883234
P. rotundifolia (Turcz.) Benth.	L.A. Orthia	61	CANB	AY883235
P. scabra R.Br.	R.P.J. de Kok	909	CANB	AY883236
P. sericea (Benth.) Corrick	J. Mant	72	CANB	AY883237
P. setulosa Benth.	R.P.J. de Kok	716	CANB	AY883238
P. skinneri F.Muell.	L.A. Orthia	36	CANB	AY883239
P. sp. Mt Lesueur (Beard 7827)	J.S. Beard	7827	PERTH	AY883398
P. spinosa (DC.) H.B.Will.	R.P.J. de Kok	cultivated	–	AY883240
P. spinulosa (Turcz.) Benth.	L.A. Orthia	68	CANB	AY883241
P. stipularis Sm.	R.P.J. de Kok	701	CANB	AY883242
P. stricta Sims	R.P.J. de Kok	729	CANB	AY883243
P. strobilifera Meisn. 1	L.A. Orthia	44	CANB	AY883392
P. strobilifera Meisn.2	L.A. Orthia	52	CANB	AY883393
P. strobilifera Meisn.3	L.A. Orthia	75	CANB	AY883394
P. subalpina (F.Muell.) Druce	R.P.J. de Kok	721	CANB	AY883244
P. subspicata Benth.	R.P.J. de Kok	718	CANB	AY883245
P. tarik de Kok	R.P.J. de Kok	666	CANB	AY883246
P. tenuifolia R.Br. & Sims 1	L.A. Orthia	64	CANB	AY883247
P. tenuifolia R.Br. & Sims 2	R.P.J. de Kok	803	CANB	AY883248
P. trichophylla H.B.Will. ex J.M.Black	R.P.J. de Kok	838	CANB	AY883249
P. trifida J.M.Black	R.P.J. de Kok	819	CANB	AY883250
P. trinervis J.M.Black	R.P.J. de Kok	801	CANB	AY883251
P. tuberculata Pers.	R.P.J. de Kok	702	CANB	AY883252
P. verruculosa Turcz.	L.A. Orthia	45	CANB	AY883253
P. vestita R.Br. ex Aiton	R.P.J. de Kok	830	CANB	AY883254
P. victoriensis Corrick	R.P.J. de Kok	762a	CANB	AY883255
P. villifera Sieber ex. DC.	R.P.J. de Kok	828	CANB	AY883256
P. viscidula Tate	R.P.J. de Kok	833	CANB	AY883257
P. vrolandii Maiden	R.P.J. de Kok	784	CANB	AY883258
P. whiteana S.T.Blake	M.D. Crisp	9113	CANB	AY883259
P. williamsoniana J.H.Willis	R.P.J. de Kok	754	CANB	AY883260
P. wudjariensis Orthia	C.E. Woolcock	2250	CBG	AY883261
Stonesiella Crisp & P.H.Weston				
S. selaginoides (Hook.f.) Crisp & P.H.Weston	R. Burns	258	CBG	AF113791
Urodon Turcz.				
U. capitatus Turcz.	M.D. Crisp	8523	CANB	AF113792
OUTGROUPS				
Daviesia Sm.				
D. elliptica Crisp	M.D. Crisp	9051	CANB	AF518130
D. flava Pedley	I.R.D. Telford	12,054	CBG	KY426177
D. longifolia Benth.	M.D. Crisp	9246	CANB	KY426196
Sphaerolobium Sm.				
S. medium R.Br.	M.D. Crisp	8942	CANB	AF518136
S. minus Labill.	M.D. Crisp	9054	CANB	AF518135
S. nudiflorum (Meisn.) Benth.	R. Butcher	1229A	PERTH	AF518137

3. Results

The sequence data comprised 200 sequences for *trn*L-F including the outgroup samples (Table 2). Alignment and character statistics are shown in Table 3. Stationarity and mixing were confirmed with an effective sample size of 79,932; a mean standard deviation of the split allele frequencies of 4.931×10^{-3}; and consistency in the tracer run.

Table 3. Descriptive statistics for *trn*L-F alignment.

	***trn*L-F**
Number of samples	200
Sequence length range (bp)	518–934
Aligned length (bp)	934
GC content (%)	32.2
Variable sites	680
Gaps + missing characters (%)	11.6

Sphaerolobium is strongly supported as a monophyletic clade sister to core Mirbelieae. The posterior tree is dominated by a hard polytomy from which all major clades of core Mirbelieae are derived (Figure 1). This limits the degree to which relationships between clades can be discussed, so instead, we will focus on the major clades that are strongly supported within polytomy and their correlation with currently recognised genera. Significantly, we recover a moderately supported clade that contains most *Pultenaea* species, with four strongly supported subclades within this clade. Support for this clade, probably the first to diverge in core Mirbelieae, appears to be influenced by outgroup selection, as analyses including more outgroup taxa recover the same clade with strong support (>0.95) (not shown). Three of these subclades are endemic to southeastern Australia, while one also has numerous species in southwestern Australia. Core *Oxylobium* is strongly supported as monophyletic, with the inclusion of *Mirbelia oxylobiodes* F.Muell., which is formally transferred to *Oxylobium* below. *Dillwynia*, *Eutaxia*, *Jacksonia*, *Leptosema* and *Phyllota* are all strongly supported as monophyletic based on only limited sampling. *Aotus* is separated into two lineages based on just four included species, reflecting its diverse morphology. *Euchilopsis* and *Urodon* are together weakly supported as sister to *Phyllota*. A clade of Western Australian species currently included in *Pultenaea* s.l. is strongly supported as sister to *Latrobea*, which is strongly supported as monophyletic based on two included species. The position of '*Otion microphyllum*' is not supported but it has morphological affinities to *Aotus*.

Mirbelia is strongly supported as monophyletic, with the exception of *M. oxylobioides* F.Muell. which clearly belongs in Oxylobium. The position of *Pultenaea brachytropis* Benth. is not supported. It appears, on morphology, to be allied to *P. craigiana* C.F.Wilkins, Orthia and Crisp (not sampled), and the two species may form an independent lineage. A second clade of Western Australian species currently included in *Pultenaea* s.l. is strongly supported as sister to a clade that includes *Stonesiella*, *Almaleea* and *Pultenaea adunca Turcz*., making this a morphologically heterogenous clade. The relationship between the *Chorizema* species and the type clade of *Podolobium* remains unclear, as these nodes are not supported in our analyses, but it is possible that these two genera should be united. Three species of *Podolobium* are strongly supported as sister to *Callistachys lanceolata*, and they are formally recognised as *Callistachys* species below. Finally, there is strong support for the broad concept of *Gastrolobium* adopted by Chandler et al. [50]. This definition of *Gastrolobium* includes significant morphological diversity, reflecting the fact that it now includes the former genera *Brachysema* R.Br., *Jansonia* Kippist and *Nemcia* Domin and *Oxylobium lineare* (Benth.) Benth. (= *Gastrolobium ebracteolatum* G.Chandler and Crisp).

4. Discussion

As highlighted by Orthia et al. [34,36], the resolution of monophyletic genera is impossible from these data unless the entirety of core Mirbelieae is incorporated in a single mega-genus, to which the name *Pultenaea* would apply. Such a proposal has met with significant resistance from both the general public and botanical community, so it is our hope that recent advances in sequencing technology can generate novel data to resolve relationships among the majority or all of the lineages that currently form the hard polytomy recovered in our analyses. If these relationships can be resolved, then a classification can be proposed that minimises taxonomic disruption and maintains as many traditionally recognised genera as possible, though significant re-circumscription of some genera appears inevitable [34,36].

Careful assessment and reanalysis of molecular data (from the *trn*L-F marker) available on GenBank, including a larger number of taxa, does recover a higher proportion of supported monophyletic clades than found by Orthia et al. [34,36], including a clade containing most *Pultenaea* species (130 of 148). *Pultenaea* is the largest genus in the tribe, and it contains a high degree of morphological and phenotypic variation. The *Pultenaea* species excluded from the core clade are all endemic to south-western Australia, and their inclusion in *Pultenaea* has been questioned previously [96].

4.1. How to Resolve Generic Relationships within Mirbelieae?

The close evolutionary history of the Mirbelieae, which is potentially due to hybridisation, incomplete lineage sorting and recent radiation [34,36], can make genetic identification of closely related species and individuals very difficult. This is often due to little genetic sequence divergence, which is especially problematic when using traditional approaches such as DNA barcoding [151]. However, for groups that may have recently diversified, population genetic markers, such as microsatellites, are an excellent way to determine genetic differences between closely related species [152–154]. In many cases, these closely related species share a close geographic range, which can lead to interspecific hybridisation and outbreeding depression, which can affect species delimitation [155].

Next-Generation Sequencing has revolutionised the way that we handle and think about molecular data, due to its ability to sequence whole genomes. However, the costs and bioinformatics processing associated with full-genome studies are often intractable under most research budgets, and for answering most evolutionary and phylogenetic questions, this quantity of data is not required [156]. Techniques, such as restriction associated DNA sequencing (RADseq), offer an excellent and cost-effective approach that can be used to find informative genome-wide markers and provide unprecedented phylogenetic resolution [157]. However, markers developed by using RADseq are taxon-specific and not cross-applicable between genera or families [158]. In recent years, huge advances have been made in targeted sequence capture that allow for the enrichment of hundreds of informative markers throughout the genome that are cross-applicable throughout angiosperms and gymnosperms [159–163].

Johnson et al. [164] have recently developed a commercially available targeted baits probe set (myBaits Angiosperms 353) that can generate a range of informative low-copy exons from the nuclear genome, which are cross-applicable across angiosperms. This baits set has particular utility for herbarium specimens that are up to 100 years old or sometimes older [162]. To date, the Angiosperms 353 probe set has provided impressive phylogenetic resolution in *Schefflera* J.R. Forst. and G. Forst. [165], Cyperaceae [160,161,166] and Gesneriaceae [167], providing unprecedented support at both the backbone and species levels. Additionally, the myBaits Angiosperms 353 kit, currently being used as part of the Plant and Fungal Trees of Life (PAFTOL) [163,164,168], is a method that will form part of the Phylogenomics Working Group (PWG) of the Genomics for Australian Plants Framework Data Initiative (GAP; https://www.genomicsforaustralianplants.com (accessed on 25 April 2021)), setting a new standard for angiosperm genomics.

The resolution of tribal, generic and species relationships within Fabaceae tribe Mirbelieae can realistically only be obtained by the targeted sampling of key species for the generation of significant new molecular data [34,36]. The aim of such sampling is to develop a new classification that minimises nomenclatural changes. Considering the complexity and possible recent radiation of Mirbelieae, construction of a well-supported phylogeny will require the use of rich and phylogenetically informative low-copy markers to allow for competing phylogenetic signals in the data to be identified and resolved [159]. Using targeted capture for Mirbelieae should not only provide good phylogenetic resolution of genera but also at the species level [169]. Therefore, the use of target capture sequencing should directly aid in species circumscription. A significant number of species complexes still require resolution (at least 28 in *Pultenaea* s. s.; unpubl. data by the authors), so this is an important consideration when selecting a technique.

To accomplish this, we will utilise Next-Generation Sequencing in the form of targeted baits capture using the myBaits Angiosperms 353 universal probe set in order to obtain informative markers from the nuclear genome [163,164]. Enabling the sequencing of a large number of informative low-copy markers throughout the nuclear genome at an affordable cost should allow us to resolve the relationships between major clades and therefore redefine genera. We will sample multiple individuals within the example species complexes in order to test the utility of the PAFTOL markers [163] for resolution of such taxonomic problems, guiding future studies. Where we are able to resolve species limits within this project, we will revise or create new descriptions for the Australian *eFlora* and publish new species as required.

A wide range of DNA samples have already been collected by the authors of this paper and continued targeted fieldwork will ensure that the most important taxa and populations can be included in order to address our key questions. Currently, silica-dried DNA samples are held for ~95% of key taxa required for molecular work (subset from >1300 samples of Faboideae held by project collaborators, with additional samples in the NSW DNA bank). Further samples will be obtained through fieldwork for the remaining species to represent all the key clades of Mirbelieae in order to provide the maximum phylogenetic resolution and support from the Angiosperms 353 bait set [162,163]. Sampling from herbarium specimens will also be undertaken where no field-collected material is available. It is critical that all key taxa (including all type species) are included in a phylogeny to help fully resolve generic level phylogenetic relationships in Mirbelieae.

4.2. Current Availability of Descriptive Information and Interactive Identification Tools

4.2.1. Online Floras

Most pea-flowered legumes are yet to be treated in the *Flora of Australia*, with the first generic treatments only recently being added to the *eFlora* platform (e.g., *Indigastrum* Jaub. & Spach.). To date, the only genus in Tribe Mirbelieae submitted for the *Flora of Australia* is *Gastrolobium* (109 spp.). This treatment will be updated, where required, to include new species (three putative new species and one published since submission [84]) for online publication.

Published revisions and regional flora treatments are available for most species in 15 Mirbelieae genera: *Almaleea* (5 spp.); *Callistachys* (5 spp.); *Chorizema* (28 spp.); *Daviesia* (130 spp.); *Dillwynia* (32 spp.); *Eutaxia* (24 spp.); *Gastrolobium* (113 spp.); *Gompholobium* (45 spp.); *Jacksonia* (74 spp.); *Leptosema* (12 spp.); *Mirbelia* (36 spp.); *Pultenaea* s.s. (130 spp.); *Sphaerolobium* (22 spp.); *Stonesiella* (1 sp.); and *Viminaria* (1 sp.). Flora accounts of nine genera without recent revisions still need to be completed: *Aotus* s.l. (22 spp.); *Erichsenia* (1 sp.); *Euchilopsis* (1 sp.); *Isotropis* (15 spp.); *Latrobea* (9 spp.); '*Otion*' (5 spp.); *Oxylobium* (7 spp.); *Phyllota* (10 spp.); and *Urodon* (4 spp.). A few anomalous species may be placed in the new genera, or in expanded definitions of existing genera. Two lineages currently included in *Pultenaea* s.l., both endemic to Western Australia, appear to be well-supported clades sister to other Western Australian genera, and new generic names may be required for these clades if they continue to be supported by additional data and sampling. '*Otion*' remains an informal name that also requires formal circumscription and validation. In summary, current taxonomic descriptions are available in the published literature for 595 species, while 160 species need revised or new descriptions (at least 32 of these species are unnamed).

The release of profiles on the Australian *eFlora* under current generic circumscriptions is not seen to be a viable option, as many of the generic and species boundaries are known to be problematic. An example is the generic name '*Otion*', first proposed in 1982, but never formalised, leaving its constituent species orphaned. Combining these into *Pultenaea* s.l. until generic boundaries are resolved would only further distort the circumscription of that genus and be problematic. The definition of *Pultenaea* s.s. is also especially challenging at present, but the transfer of just 18 species from *Pultenaea* will likely resolve this as the remainder of *Pultenaea* species are resolved as a monophyletic clade.

Published revisions are available for 595 species within Mirbelieae, leaving 160 species that require revision, or new descriptions (Table 4). We aim for the completion of *eFlora* treatments for all taxa in tribe Mirbelieae (24–33 genera and ca. 755 species). Treatments have already been provided to ABRS for an additional 57 pea genera (including 483 species) from other tribes. An ongoing project by R. Butcher, I.D. Cowie & T.D. Macfarlane et al. ([170–176]; Butcher, unpublished data) to revise Australian *Tephrosia* Pers. will add ca. 111 species. At the completion of these projects, ca. 1370 species will be available for *eFlora*, leaving a gap of ca. 393 species for completion of Fabaceae for the *Flora of Australia*.

Table 4. Summary of genera in tribe Mirbelieae reflecting putative phylogenetic relationships, number with molecular data, and progress towards *eFlora* treatments. Genera or clades marked with an * are yet to be adequately circumscribed and require additional genetic data.

Genus (or Unnamed Clade)	Number of Species	No. of Species with DNA Sequence Data/No. of Sequences	Published Descriptions Available	New or Revised Descriptions Required
Core Mirbelieae				
Almaleea	5	1/4	5	0
* *Aotus* s.s.	6	4/6	0	6
* *Aotus* Clade A	3	2/5	1	2
* *Aotus* Clade B	3	0	2	1
* *Aotus* Clade C	10	0	0	10
Callistachys s.l.	5	4/17	3	2
* *Chorizema* s.l.	28	18/32	28	0
* *Dillwynia*	36	3/7	4	32
Euchilopsis	1	1/4	0	1
* *Eutaxia* s.s.	12	3/6	12	0
Gastrolobium	109	82/313	109	0
Jacksonia	74	6/15	74	0
* *Latrobea*	9	4/12	3	6
Leptosema	12	2/5	12	0
* *Mirbelia*	26	15/65	28	8
* *'Otion'* ined.	5	1/2	1	4
Oxylobium	7	6/40	1	6
* *Phyllota*	10	2/7	1	9
* *Podolobium*	3	3/17	3	0
Pultenaea s.s.	130	58/222	83	47
* *Pultenaea* Clade A	1	1/3	1	0
* *Pultenaea* Clade B	2	2/6	2	0
* *Pultenaea* Clade C	9	9/28	7	2
* *Pultenaea* Clade D	6	6/18	6	0
* *Sclerothamnus* R.Br.	12	0	10	2
Stonesiella	1	1/1	1	0
Urodon	4	2/4	0	4
Mirbelieae s.l.				
Daviesia	130	130/419	130	0
Erichsenia	1	1/3	0	1
Gompholobium	46	5/9	46	0
Isotropis	15	4/18	3	12
Sphaerolobium	22	3/7	22	0
Viminaria	1	1/4	1	0
Total Mirbelieae s.l.	755	385/1298	595	160

4.2.2. Interactive Keys

The Pea Key provides a user-friendly resource for the identification of Australian Faboideae [138]. However, technological changes since its first edition, released in 2007, require the key to be updated with improved accessibility. Less than 50 species of Mirbelieae need to be added and the functionality of the key must be improved in order to make it more attractive and to increase its use by a wider audience. An expansion of the character sets for Mirbelieae species would enable a more reliable tool in the identification of taxa to species-level.

The Pea Key currently includes ca. 1500 species among 136 genera, based on 67 descriptive characters (hosted by ANBG, last updated 2007). A new interactive key has recently been published on *FloraBase* for Western Australian peas [177]. This key is based on 70 characters, is well-illustrated, and is user-friendly. The WA key provides an excellent tool to aid in the identification of 507 Mirbelieae species, and we aim to update existing data, images and illustrations in *The Pea Key* for the 247 Mirbelieae species that occur outside of Western Australia in order to align with, and complement, the Western Australian pea key. A new interactive key has also been completed for Victoria, covering 309 species based on 50 characters [139].

Images and descriptive data were mostly absent in the first edition of *The Pea Key*. Rather than creating a stand-alone dataset of descriptive information and images, it is proposed that the second edition links to the newly created *eFlora* platform through unique identifiers provided by the Atlas of Living Australia (ALA). Linking to the *eFlora* will automatically utilise images in the Australian Plant Image Index (APII). Images of key morphological features provide powerful identification aids and representative images are provided to demonstrate the large range of morphological variation found in the tribe (Figures 2–6).

4.3. Conclusions for Future Taxonomic Classification

Core Tribe Mirbelieae, as defined here, currently includes 18 genera, but our findings show that at least some of these genera cannot be maintained in their current circumscriptions. Options that create monophyletic genera include the recognition of a single large genus, or up to 27 genera (in which case up to six genera would be new). We propose to use targeted sampling of all recognised and possible novel genera, representing known diversity in the group, in order to determine a novel generic level classification that minimises taxonomic changes. We anticipate that with new data to confirm relationships between the major lineages identified in our study, the majority of *Pultenaea* species can be retained in that genus. The large genera *Gastrolobium*, *Jacksonia* and *Mirbelia* are likely to be maintained in the current circumscriptions. Most of the other genera in core Mirbelieae require further sampling to determine revised monophyletic units that have utility as genera. This resolution is critical to the appropriate placement of species in the Australian *eFlora*.

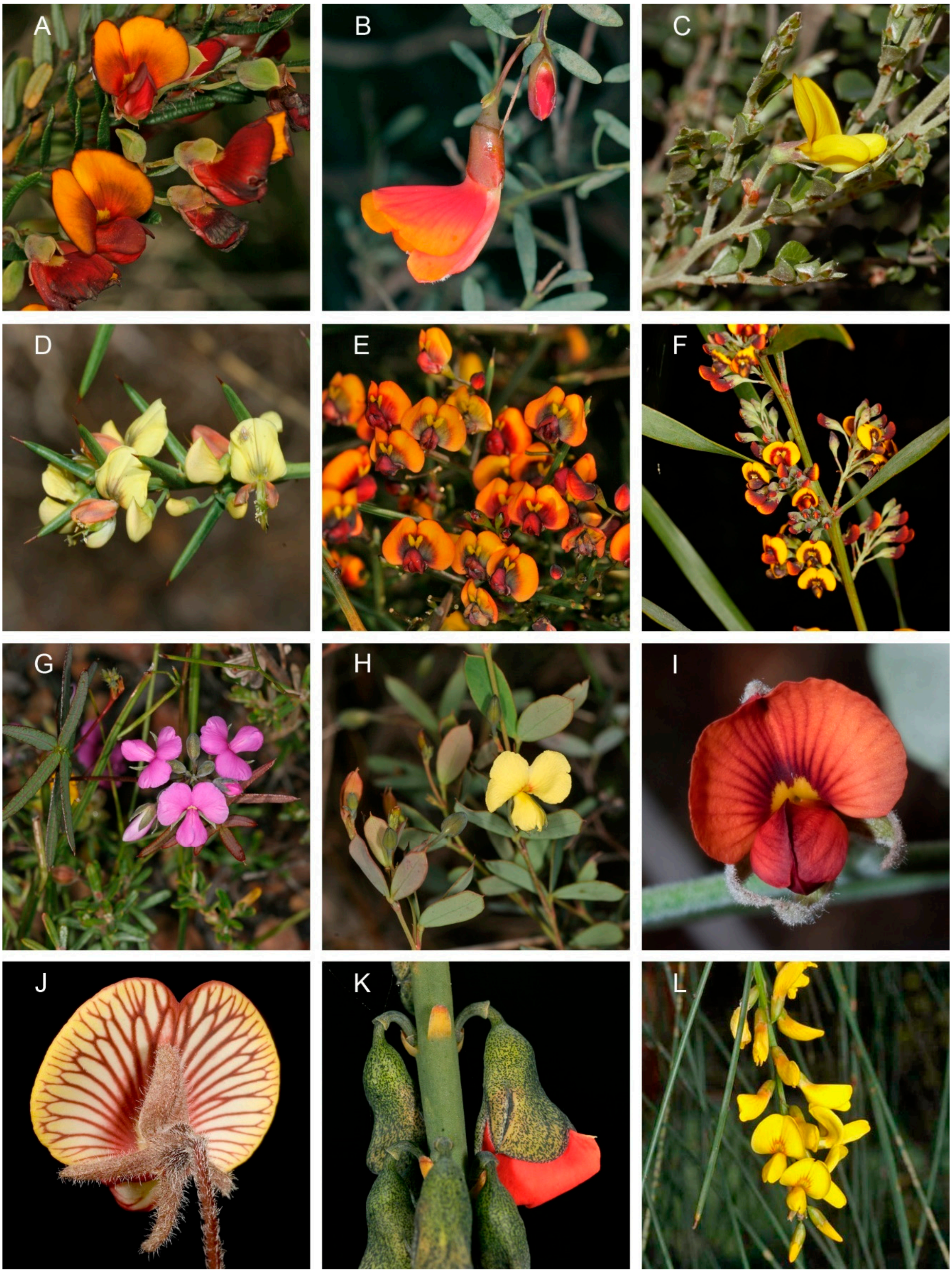


Figure 2. Morphological diversity of representative species from Fabaceae tribe Bossiaeeae (sister to Mirbelieae) and non-core Mirbelieae. (**A**) *Bossiaea eriocarpa*. (**B**) *Bossiaea preissii*. (**C**) *Bossiaea sericea*. (**D**) *Daviesia angulata*. (**E**) *Daviesia hakeoides*. (**F**) *Daviesia mimosoides* subsp. *mimosoides*. (**G**) *Gompholobium knightianum*. (**H**) *Gompholobium marginatum*. (**I**) *Isotropis atropurpurea*. (**J**) *Isotropis cuneifolia* subsp. *cuneifolia* (calyx and rear face of corolla). (**K**) *Sphaerolobium drummondii*. (**L**) *Viminaria juncea*. Photographs by Russell Barrett except (**J**) by Kevin Thiele and (**L**) by Murray Fagg from the Australian Plant Image Index: http://www.anbg.gov.au/photo (accessed on 11 June 2021).

Figure 3. Morphological diversity of representative species from Fabaceae tribe Mirbelieae (core Mirbelieae). (**A**) *Almaleea incurva*. (**B**) *Aotus gracillima*. (**C**) *Aotus lanigera*. (**D**) *Callistachys lanceolata*. (**E**) *Callistachys scandens*. (**F**) *Chorizema rhombeum*. (**G**) *Chorizema varium*. (**H**) *Dillwynia ericifolia*. (**I**) *Dillwynia phylicoides*. (**J**) *Dillwynia retorta*. (**K**) *Dillwynia sericea*. (**L**) *Erichsenia uncinata*. Photographs by Russell Barrett except (**A**,**D**,**G**) by Murray Fagg and (**B**,**L**) by Kevin Thiele ((**A**,**B**,**D**,**G**,**L**) from the Australian Plant Image Index: http://www.anbg.gov.au/photo (accessed on 11 June 2021)).

Figure 4. Morphological diversity of representative species from Fabaceae tribe Mirbelieae (core Mirbelieae). (**A**,**B**) *Euchilopsis linearis*. (**C**) *Eutaxia microphylla*. (**D**) *Eutaxia virgata*. (**E**) *Gastrolobium hookeri*. (**F**) *Gastrolobium propinquum*. (**G**) *Gastrolobium reticulatum*. (**H**) *Gastrolobium sericeum*. (**I**) *Gastrolobium sowardii*. (**J**) *Jacksonia aculeata*. (**K**) *Jacksonia capitata*. (**L**) *Jacksonia compressa*. Photographs by Russell Barrett except (**C**), by Murray Fagg ((**C**) from the Australian Plant Image Index: http://www.anbg.gov.au/photo (accessed on 11 June 2021)).

Figure 5. Morphological diversity of representative species from Fabaceae tribe Mirbelieae (core Mirbelieae). (**A**) *Jacksonia restioides*. (**B**) *Latrobea glabrescens*. (**C**) *Leptosema anomalum*. (**D**) *Leptosema aphyllum*. (**E**) *Leptosema chambersii*. (**F**) *Mirbelia dilatata*. (**G**) *Mirbelia floribunda*. (**H**) *Mirbelia rhagodioides*. (**I**) *Mirbelia rubiifolia*. (**J**) *Mirbelia trichocalyx*. (**K**) *Mirbelia viminalis*. (**L**) *'Otion' simplicifolium*. Photographs by Russell Barrett except (**A**) by Michael Crisp, (**D**,**E**) by Murray Fagg and (**F**) by Kevin Thiele ((**D**–**F**) from the Australian Plant Image Index: http://www.anbg.gov.au/photo (accessed on 11 June 2021)).

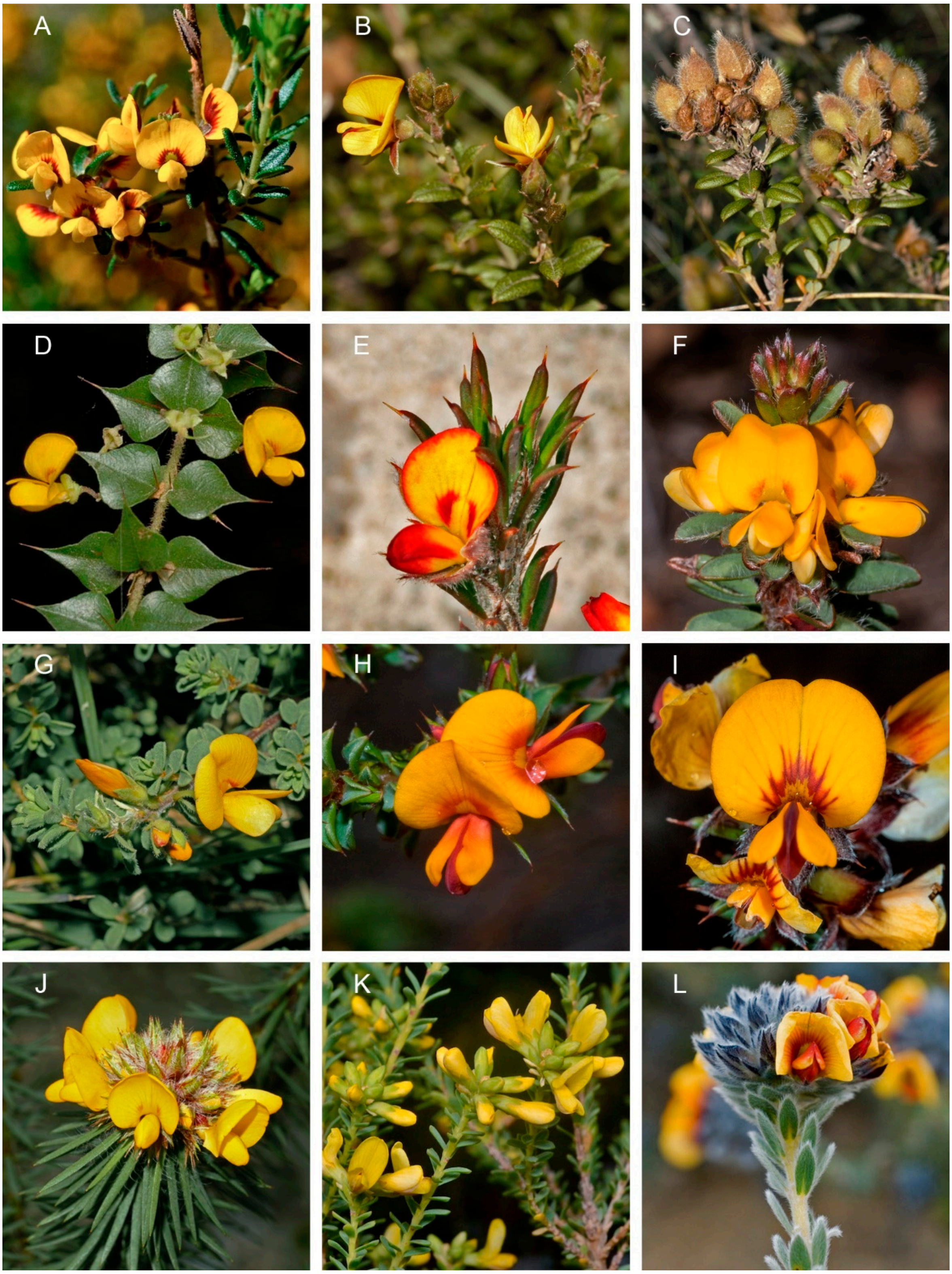


Figure 6. Morphological diversity of representative species from Fabaceae tribe Mirbelieae (core Mirbelieae). (**A**) *Oxylobium cordifolium*. (**B**) *Oxylobium oxylobioides* (flowering). (**C**) *Oxylobium oxylobioides* (fruiting). (**D**) *Podolobium aciculiferum*. (**E**) *Pultenaea brachyphylla*. (**F**) *Pultenaea ferruginea*. (**G**) *Pultenaea maritima*. (**H**) *Pultenaea procumbens*. (**I**) *Pultenaea sp. Olinda*. (**J**) *Pultenaea stipularis*. (**K**) *Stonesiella selaginoides*. (**L**) *Urodon dasyphyllus*. Photographs by Russell Barrett except (**A**,**D**,**K**,**L**) by Murray Fagg ((**A**,**D**,**K**,**L**) from the Australian Plant Image Index: http://www.anbg.gov.au/photo (accessed on 11 June 2021)).

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Taxonomy

Mirbelieae s.s.

While many changes in generic circumscription are expected, most require more data and better sampling before the best nomenclatural solutions can be determined [34,36]. However, there is sufficient support to justify a few taxonomic changes and these are validated below. The opportunity is taken to select types for genera where type species have never been designated, as far as we can determine. Specific lectotypes for species and infraspecific taxa are also designated in order to place names correctly in advance of a new global checklist of Fabaceae (R. Govaerts et al. in prep. http://sftp.kew.org/pub/data_collaborations/Fabaceae/DwCA/ (accessed on 29 June 2021)). A nomenclatural summary is presented for all Mirbelieae genera.

Almaleea Crisp & P.H. Weston, *Telopea* 4(2): 309 (1991). *Type*: *Almaleea incurvata* (A. Cunn.) Crisp & P.H. Weston

Aotus Sm. in K.D.E. Koenig, & J. Sims (eds), *Annals of Botany* 1(3): 504 (1805). *Type*: *Aotus villosa* (Andrews) Sm. [=*A. ericoides* (Vent.) D.Don]

Callistachys Vent., *Jardin de la Malmaison* 2(20): 115, pl. 115 (1805). *Type*: *Callistachys lanceolata* Vent.

Notes: *Callistachys* has been rejected against the conserved name *Oxylobium* Andrews (1807) [178] if the two genera are united, but this has no effect when they are considered distinct genera. We anticipate that the two genera will both remain accepted.

Three eastern Australian species previously included in *Podolobium* are clearly closely related to the Western Australian species *Callistachys lanceolata* (Figure 1C; [179]), and they are here included in *Callistachys* where names are already available [40].

Callistachys alpestris (F. Muell.) Kuntze, *Revisio Generum Plantarum* 1: 168 (1891).

Oxylobium alpestre F. Muell., *Definitions of rare or hitherto undescribed Australian plants* 5 (1855). *Podolobium alpestre* (F. Muell.) Crisp & P.H. Weston in Crisp, M.D. & Doyle, J.J. (eds.) *Advances in Legume Systematics* 7: 280 (1995).

Type citation: 'Not unfrequent in the higher parts of the Australian Alps.'

Type: Mount Buller, 5000 ft [1540 m], Victoria, Apr. 1853, *F. Mueller s.n.* (lecto, here designated: MEL 624821; isolecto: K 000642469). *Residual syntypes*: Australian Alps, Victoria, *F. Mueller s.n.* (K 000642470, MEL 624820). Mount Timbertop, Victoria, 26 Mar.

1853, *F. Mueller s.n.* (MEL 624824). Subalpine mountains on the Berrima, Victoria, *F. Mueller s.n.* (MEL 624822). In alpestre Great Dividing Range and in alpe Mt Cobberas, Victoria, 5-6000 ft, Jan. 1854, *F. Mueller s.n.* (K 000642467, MEL 624823, TCD 0014295*). Mitta Mitta, 4-5000 ft, *F. Mueller s.n.* (K 000642468). Munyang Mountains, Victoria, *F. Mueller s.n.* (BM 000885480, M 0219088*, PH 00017792*). Mount Hotham, Victoria, *F. Mueller s.n.* (BM 000885479). Victorian Alps, *Walter s.n.* (BM 000885478).

Oxylobium alpestre F. Muell., *Victoria—Parliamentary Papers- Votes and Proceedings of the Legislative Assembly* 3, 12 (1853), *nom. inval.*, *nom. nud*.

Notes: Mueller [180] described the fruit of this species, with no details of the flowers. Numerous syntypes have been located, many without collection dates. It is unknown whether he did have flowering material, so both fruiting and flowering sheets are considered syntypes. We select a fruiting sheet at MEL as the lectotype as this is one of the the largest specimens at MEL, it has a collection date firmly establishing that it was collected before the species was named, and it is also a good match for the protologue. There is also a duplicate at K.

Callistachys procumbens (F. Muell.) Kuntze, *Revisio Generum Plantarum* 1: 168 (1891).

Oxylobium procumbens F. Muell., *Definitions of rare or hitherto undescribed Australian plants* 4–5 (1855). *Podolobium procumbens* (F. Muell.) F. Muell. ex Crisp & P.H. Weston in Crisp, M.D. & Doyle, J.J. (eds.) *Advances in Legume Systematics* 7: 281 (1995).

Type citation: 'On wooded hills; for instance, at Mount Disappointment, in the Goulburn Ranges, on the Delatite, in the Black Forest, at Ballarat, etc.'

Type: Black Forest, Victoria, Dec. 1852, *F. Mueller s.n.* (lecto, here designated: MEL 624827; isolecto: MEL 624828). *Residual syntypes*: Delatite River, Victoria, 18 Mar. 1853, *F. Mueller s.n.* (K 000642444, MEL 624829). Gipps Land [Gippsland] Range, *F. Mueller s.n.* (TCD 0014277). In the stringybark ranges ... the Glenelg and Goulbourn [Rivers] Victoria, 8 Feb. 1853, *F. Mueller s.n.* (MEL 569724). Australia Felix [Victoria], *n.d., F. Mueller s.n.* (MEL 624825). *Possible syntype*: Hume River, New South Wales, [received 1887], *F. Mueller s.n.* (M 0219079*).

Podolobium procumbens F. Muell., *Victoria—Parliamentary Papers- Votes and Proceedings of the Legislative Assembly* 3, 12 (1853), *nom. inval.*, *nom. nud*.

Notes: Mueller [180] cited a range of localities. We select a specimen at MEL from the Delatite River as lectotype, as it is excellent fertile material and there is a duplicate sheet. A specimen from the Hume River may or may not fall within the scope of the protologue and has no collection date, so its type status is uncertain.

Callistachys scandens (Sm.) Kuntze, *Revisio Generum Plantarum* 1: 168 (1891).

Chorizema scandens Sm. in K.D.E. Koenig, & J. Sims (eds), *Annals of Botany* 1(3): 506 (1805). *Podolobium scandens* (Sm.) DC., *Prodromus Systematis Naturalis Regni Vegetabilis* 2: 103 (1825). *Oxylobium scandens* (Sm.) Benth., *Commentationes de Leguminosarum Generibus* 6 (1837).

Type citation: 'Port Jackson.'

Type: Port Jackson [Sydney], New South Wales, 1793, *Mr. White s.n.* (lecto, designated by M.D. Crisp et al. in Crisp, M.D. & Doyle, J.J. (eds), *Advances in Legume Sytematics* 7: 281 (1995)): LINN-HS728-3; isolecto: ?BM 000885551, LIV, P 00337501).

Note: See Crisp & Weston [40] for a full list of synonyms. Crisp et al. [33] cite the type of the name *Chorizema scandens* as 'Holo: Port Jackson, N.S. Wales, Mr. White, 1793 (LINN); iso: ?BM, LIV, ?P.' This is here treated as effective lectotypification in accordance with ICN Art. 7.11 [181].

Chorizema Labill., *Relation du Voyage a la Recherche de la Perouse* 1: 404, pl. 21 (1800). *Type*: *Chorizema ilicifolia* Labill.

Orthotropis Benth. ex Lindl., *Edwards's Botanical Register Appendix*: xvi (1839). *Type*: *Orthotropis pungens* Lindl. [=*Chorizema aciculare* (DC.) C.A. Gardner]

Note: *Podolobium s.s.* may be embedded within *Chorizema*, but further data are required to test this.

Dillwynia Sm. in K.D.E. Koenig, & J. Sims (eds.), *Annals of Botany* 1(3): 510 (1805), *non* Roth (1806). *Type*: *Dillwynia ericifolia* Sm., designated by L.K.G. Pfeiffer, *Nomencl. Bot.* 12: 136 (1874).
Dillwynia sect. *Xeropetalum* R.Br. ex Sims, *Curtis's Botanical Magazine* 48: 2247, subt. (1821). *Type*: *Dillwynia cinerascens* R.Br.
Xeropetalum Rchb., *Conspectus regni vegetabilis per gradus naturales evoluti. Tentamen* 154 (1828), *nom. inval.*, *nom. nud.*, *non* Delile (1826).
Dillwynia sericea subsp. ***glabriflora*** (Blakely) Jobson & P.H. Weston, *comb. et stat. nov*.
Basionym: *Dillwynia sericea* var. *glabriflora* Blakely, *The Australian Naturalist* 10(6): 185 (1939).
Type: Pilliga Forest [Scrub], Sept. 1913, *E.H.F. Swain 29* (holo: NSW 40780; iso: CBG 8313107).
Dillwynia sericea subsp. ***rudis*** (Sieber ex DC.) Jobson & P.H. Weston, *comb. et stat. nov*.
Basionym: *Dillwynia rudis* Sieber ex DC., *Prodromus Systematis Naturalis Regni Vegetabilis* 2: 109 (1825). *Type*: [Sydney region, New South Wales], 1823, *F. Sieber pl. exs. nov.-holl. n. 400* (lecto, here designated: G 00488223*; isolecto: BM 000885863, BR 0000013455989*, G 00365064*, G 00365100*, H 1275852*, K 000858585, M 0219096*, MEL 624489, MO 277045*, MPU 021245*, NSW 40727, S-G-9090, TCD 0014717*, W 0045220, W 0045221, W 19890005724).
Notes: There are many sheets of Sieber's *pl. exs. nov.-holl. n. 400*, including at G, so we here designate the sheet from de Candolle's herbarium as lectotype as we know this is material originally examined by de Candolle.
Dillwynia sparsifolia (F. Muell.) Jobson & P.H. Weston, *comb. nov*.
Basionym: *Eutaxia sparsifolia* F. Muell., *Definitions of rare or hitherto undescribed Australian plants* 39–40 (1855).
Type citation: 'In the desert scrub towards the mouth of the Murray River. Found also at Tumbay Bay by Mr. C. Wilhelmi.'
Type: Tumby Bay, Spencers Gulf, [South Australia], *C. Wilhelmi s.n.* (lecto, here designated: MEL 2138746). *Probable syntype*: Near Lake Alexandrina, [South Australia], Oct. 1848, *F. Mueller s.n.* (MEL 2138744).
Notes: Mueller's concept of *Eutaxia sparsifolia* appears to equate with *Eutaxia patula* F. Muell. ex D. Dietr [180]. The material cited for *Eutaxia sparsifolia* from 'towards the mouth of the Murray River' is probably the MEL sheet also identified as a type of *Eutaxia patula*, but it does not have the name *E. sparsifolia* on the sheet. We therefore designate the Wilhelmi specimen at MEL as the lectotype of as the only definite original material of *E. sparsifolia* located.
Dillwynia trichopoda (Blakely) Jobson & P.H. Weston, *comb. et stat. nov*.
Basionym: *Dillwynia parvifolia* var. *trichopoda* Blakely, *The Australian Naturalist* 10(5): 162 (1939).
Type: Hill Top, Southern Tableland, [New South Wales], Sept. 1899, *J.H. Maiden & J.L. Boorman s.n.* (lecto, here designated: NSW 40290; isolecto: CBG 8313090, NSW450238).
Notes: Three sheets of the single gathering cited in the protologue have been located, including one sheet at CBG (ex NSW). We here designate the sheet with the largest amount of material as the lectotype.
Euchilopsis F. Muell., *The Chemist and Druggist with Australasian Supplement* 5(13): 13 (1882). *Type*: *Euchilopsis linearis* (Benth.) F. Muell.
Sphaerolobium sect. *Euchiloides* Benth., *Flora Australiensis* 2: 63, 67 (1864). *Euchilodes* Kuntze in T. von Post & O. Kuntze, *Lexikon Generum Phanerogamarum* 212 (1903), *nom. illeg.*, *nom. superfl*. *Type*: *Sphaerolobium euchilus* Benth., *nom. illeg.*, *nom. superfl.* [=*Euchilopsis linearis* (Benth.) F. Muell.]
Eutaxia R.Br. in W.T. Aiton, *Hortus Kewensis* Edn. 2, 3: 16 (1811). *Type*: *Eutaxia myrtifolia* (Sm.) R.Br., *nom. illeg*., designated by C.F. Wilkins *et al*., *Nuytsia* 20: 111 (2010).
Sclerothamnus R.Br. in W.T. Aiton, *Hortus Kewensis* Edn. 2, 3: 16 (1811). *Eutaxia* sect. *Sclerothamnus* (R.Br.) F. Muell. *Fragmenta Phytographiae Australiae* 1(1): 7 (1858). *Type*: *Sclerothamnus microphyllus* R.Br. [= *Eutaxia microphylla* (R.Br.) C.H. Wright & Dewar]

Gastrolobium R.Br. in W.T. Aiton, *Hortus Kewensis* Edn. 2, 3: 16 (1811). *Type*: *Gastrolobium bilobum* R.Br.
Brachysema R.Br. in W.T. Aiton, *Hortus Kewensis* Edn. 2, 3: 10 (1811). *Type*: *Brachysema latifolium* R.Br. [= *Gastrolobium latifolium* (R.Br.) G.Chandler & Crisp]
Brachysema sect. *Eubrachysema* Benth., *Flora Australiensis* 2: 9, 10 (1864), *nom. inval*.
Jansonia Kippist, *The Gardeners' Chronicle and Agricultural Gazette* 19: 307 (1847). *Type*: *Jansonia formosa* Kippist ex Lindl. [= *Gastrolobium formosum* (Kippist ex Lindl.) G.Chandler & Crisp]
Cryptosema Meisn. in J.G.C. Lehmann (ed.), *Plantae Preissianae* 2(2-3): 206 (1848). *Type*: *Cryptosema pimeleoides* Meisn. [= *Gastrolobium formosum* (Kippist ex Lindl.) G.Chandler & Crisp]
Nemcia Domin, *Preslia* 2: 27 (1923). *Type*: *Nemcia coriacea* (Sm.) Domin [= *Gastrolobium coriaceum* (Sm.) G. Chandler & Crisp]
Notes: Domin included twelve species in his new genus *Nemcia* [182]. We here select *N. coriacea* as the type species, as its phylogenetic position is strongly supported, and it is a well-defined species that is representative of the genus *sensu* Domin [182].
Cupulanthus Hutch., *Dicotyledones*. *The Genera of Flowering Plants* (*Angiospermae*) 1: 341 (1964). *Type*: not designated.
Jacksonia R.Br. ex Sm. in A. Rees (ed.), *The Cyclopaedia* 18: - (1811). *Type*: *Jacksonia spinosa* (Labill.) R.Br. ex Sm., designated by J.A. Chappill *et al*., *Australian Systematic Botany* 20(6): 476 (2007).
Piptomeris Turcz., *Bulletin de la Societe Imperiale des Naturalistes de Moscou* 26(1): 257 (1853). *Jacksonia* sect. *Piptomeris* (Turcz.) Kuntze in T. von Post & O. Kuntze, *Lexikon Generum Phanerogamarum* 294 (1903). *Type*: *Piptomeris aphylla* Turcz. [= *Jacksonia racemosa* Meisn.]
Latrobea Meisn. in J.G.C. Lehmann (ed.), *Plantae Preissianae* 2(2-3): 219 (1848). *Type*: *Latrobea genistioides* (Meisn.) Meisn.
Latrobea sect. *Eulatrobea* Benth., *Flora Australiensis* 2: 140 (1864), *nom. inval*.
Leptocytisus Meisn. in J.G.C. Lehmann (ed.), *Plantae Preissianae* 2(2-3): 211 (1848). *Latrobea* sect. *Leptocytisis* (Meisn.) Benth., *Flora Australiensis* 2: 140, 141 (1864). *Type*: *Leptocytisus tenellus* (Meisn.) Meisn. [= *Latrobea tenella* (Meisn.) Benth.]
Notes: Meissner included two species in his new genus *Latrobea*, both from south-west Western Australia [65]. We here select *L. genistioides* as the type species as it is well represented by type material, while *L. brunonis* (Benth.) Meisn. is not.
Leptosema Benth., *Commentationes de Leguminosarum Generibus* 20 (1837). *Type*: *Leptosema bossiaeoides* Benth.
Kaleniczenkia Turcz., *Bulletin de la Societe Imperiale des Naturalistes de Moscou* 26(1): 252 (1853). *Type*: *Kaleniczenkia daviesioides* Turcz. [= *Leptosema daviesioides* (Turcz.) Crisp]
Burgesia F. Muell., *Fragmenta Phytographiae Australiae* 1(10): 222 (1859). *Type*: *Burgesia homaloclada* F. Muell. [= *Leptosema aphyllum* (Hook.) Crisp]
Mirbelia Sm. in K.D.E. Koenig, & J. Sims (eds), *Annals of Botany* 1(3): 511 (1805). *Type*: *Mirbelia reticulata* Sm.
Dichosema Benth. in S.F.L. Endlicher *et al*., *Enumeratio plantarum quas in Novae Hollandiae ora austro-occidentali ad fluvium Cygnorum et in Sinu Regis Georgii collegit Carolus liber baro de Hügel* 35 (1837). *Mirbelia* sect. *Dichosema* (Benth.) Kuntze in T. von Post & O. Kuntze, *Lexikon Generum Phanerogamarum* 368 (1903). *Type*: *Dichosema spinosum* Benth. [= *Mirbelia spinosa* (Benth.) Benth.]
Oxycladium F. Muell. in W.J. Hooker (ed.), *Hooker's Journal of Botany and Kew Garden Miscellany* 9: 20 (1857). *Type*: *Oxycladium semiseptatum* F. Muell. [= *Mirbelia viminalis* (A. Cunn. ex Benth.) C.A. Gardner]
Oxylobium Andrews, *The Botanist's Repository for New, and Rare Plants* 7(101): t. 492 (1807), *nom. cons*. *Type*: *Oxylobium cordifolium* Andrews
Oxylobium oxylobioides (F. Muell.) Crisp & R.L. Barrett, *comb. nov*.
Basionym: *Mirbelia oxylobioides* F. Muell., *Fragmenta Phytographiae Australiae* 2(16): 154 (1861).

Type citation: 'In vallibus profundis rupestribus montium Haidinger Range as originem fluviorum Macallister et Mitchell River, altitudine 3000–4000.'
Type: Sources of the Macallister [Macalister] River, Mar. 1861, *F. Mueller s.n.* (lecto, here designated: MEL 624816). *Possible syntypes*: Mc'Allister [Macalister] River, no date, *F. Mueller s.n.* (MEL 624817; NY 00026421). Mount Legar and Range to the N.W., no date, *F. Mueller s.n.* (K 000642571).
Typification: While MEL 624815 is labelled as a type specimen, it is clearly labelled as collected in 1863, two years after the species was named, so it cannot be original material. There is a duplicate of this specimen at NSW (NSW 31714) which is also dated 1863. The later collection locality near the Macalister River creates doubt over the undated collections that are simply labelled 'Mc'Allister River' as to whether or not they are syntypes [Muller's duplicate labels were often simplified from the original label]. Only the specimen here designated as lectotype can be confidently considered original material.
Notes: This species consistently groups with *Oxylobium* in phylogenetic analyses and notably it only has an abaxial septum in the longitudinally divided pod, a character shared with *O. robustum* Joy Thomps. [39,47].
Phyllota (DC.) DC. ex Benth. in S.F.L. Endlicher *et al.*, *Enumeratio plantarum quas in Novae Hollandiae ora austro-occidentali ad fluvium Cygnorum et in Sinu Regis Georgii collegit Carolus liber baro de Hügel* 33 (1837). *Pultenaea* sect. *Phyllota* DC. in A.P. de Candolle (ed.), *Prodromus Systematis Naturalis Regni Vegetabilis* 2: 113 (1825). *Type*: *Pultenaea phylicoides* Sieber ex DC. [= *Phyllota phylicoides* (Sieber ex DC.) Benth.]
Walpersia Harv. in Harvey & Sonder, *Fl. Cap*. 2: 26 (1861), *nom. cons.*, *non* Reissek ex Endl. (1840). *Type*: *Walpersia burtonioides* Harv. [= *Phyllota squarrosa* (Sieber ex DC.) Benth.]
Notes: de Candolle included four species of *Pultenaea* in his section *Phyllota*: *P. aspera* Sieber ex DC., *P. comosa* Sieber ex DC., *P. squarrosa* Sieber ex DC. and *P. phylicoides* Sieber ex DC., all collected by Franz Sieber in the vicinity of Sydney, New South Wales [57]. All four species were recognised by Bentham [59] when he raised the section to genus rank. However, Bentham later reduced three of these to synonymy under *Phyllota phylicoides* (Sieber ex DC.) Benth. [62] *Phyllota squarrosa* (Sieber ex DC.) Benth. has since been reinstated.
We note that Bentham [59] specifically attributed the genus name to de Candolle (probably based on de Candolle ([57]: 113) stating 'An genus proprium?' [59] We therefore accept the authorship of the genus name as '(DC.) DC. ex Benth.'
Jancey [92] undertook a detailed study of *Phyllota* in New South Wales, providing detailed notes on the type species for the species, but did not select a type for the genus. We here select *Pultenaea phylicoides* as the type of *Pultenaea* sect. *Phyllota* (and therefore of *Phyllota*), as it is only one of the four original species later recognised by Bentham [62].
Walpersia burtonioides was described as a new genus and species from South Africa based on erroneous label data and it is actually an Australian taxon [183].
Phyllota barbata Benth. in S.F.L. Endlicher *et al.*, *Enumeratio plantarum quas in Novae Hollandiae ora austro-occidentali ad fluvium Cygnorum et in Sinu Regis Georgii collegit Carolus liber baro de Hügel* 33 (1837).
Type citation: 'King Georges Sound (Hügel.)'
Type: King Georges Sound, Western Australia, *C.A.A. von Hügel 97* (lecto, here designated: W 0046869). *Residual syntypes*: King Georges Sound, Western Australia, *C.A.A. von Hügel 2* (W 0046868); King Georges Sound, Western Australia, *C.A.A. von Hügel 3* (W 0046868).
Phyllota villosa Turcz., *Bull. Soc. Imp. Naturalistes Moscou* 26(I): 267 (1853).
Type: Western Australia, 1842, *J. Gilbert 255* (lecto, here designated: KW 001001187; isolecto: K 000858466).
Typification: There are three sheets of *Phyllota barbata* at W collected by von Hügel, each with different collection numbers, so they are here regarded as syntypes. W 0046869 is designated as the lectotype as it is the only sheet that bears the name '*Phyllota barbata*' on the original labels.

Two sheets of the type collection of *Phyllota villosa* have been located. We here designate the sheet at KW as lectotype as this is the sheet used by Turczaninow when describing the species.
Notes: Orthia et al. [96] noted the morphological similarity of *Phyllota barbata* and *Pultenaea barbata* and even suggested they were possibly conspecific. We conclude that the two names might best be treated as a single species based on study of the type specimens, however the names are currently both in use for two quite distinct taxa in Western Australia, so further studies are advised on the application of both names. The two taxa were named in separate genera, but independently given the same species epithet. If the two taxa are united, the younger name has priority if the taxon is included in *Pultenaea* (as Orthia et al. [96] did); however, in *Phyllota* the older name has priority.
Podolobium R.Br. in W.T. Aiton, *Hortus Kewensis* Edn 2, 3: 9 (1811).
Type: *Podolobium trilobatum* R.Br. [= *P. ilicifolium* (Andrews) Crisp & P.H. Weston; =*Chorizema trilobum* Sm., *non Chorizema ilicifolium* Labill. (1800).]
Note: *Podolobium* is not monophyletic as circumscribed in recent literature (e.g., [40,134]), however, it probably is monophyletic with the transfer above of three species to *Callistachys*. The type species of *Podolobium* may be resolved within *Chorizema* which would have priority if the two genera are combined.
Pultenaea Sm., *A Specimen of the Botany of New Holland* 1(3): 35 (1794). *Type*: *Pultenaea stipularis* Sm.
Euchilus R.Br. in W.T. Aiton, *Hortus Kewensis* Edn. 2, 3: 17 (1811). *Pultenaea* sect. *Euchilus* (R.Br.) F. Muell., *Fragmenta Phytographiae Australiae* 1(1): 8 (1858). *Type*: *Euchilus obcordatus* R.Br. [= *Pultenaea heterochila* F. Muell.]
Bartlingia Brongn., *Memoire sur la famille des Rhamnees* 66 (1826), *nom. illeg.*, *non* Reichb. (1824). *Type*: *Bartlingia obovata* (DC.) Meisn.
Spadostyles Benth., *Commentationes de Leguminosarum Generibus* 16 (1837). *Type*: *Spadostyles cunninghamii* Benth. [=*Pultenaea spinosa* (DC.) H.B. Will.]
Notes: We here designate *Spadostyles cunninghamii* Benth. as the type species of *Spadostyles* Benth., as this is the best described of the two species included by Bentham [60], and the only name that is legitimate.
Pultenaea barbata C.R.P. Andrews, *Journal of the West Australian Natural History Society* 2(1): 38–39 (1904).
Type citation: 'I found this species in flower near the Phillips River in Oct. 1903.'
Type: Phillips River, Western Australia, Oct. 1903, *C.R.P. Andrews s.n.* (lecto, here designated: PERTH 01025805; isolecto: NSW 36498).
Pultenaea andrewsii W.E. Blackall & B. Grieve, *How to know Western Australian wildflowers: a key to the flora of the temperate regions of Western Australia* 1: 234, (1954), *nom. inval.*, *nom. nud*.
Typification: There are two sheets of the type collection of *Pultenaea barbata*. We here designate the PERTH sheet as the lectotype as it can be expected that both sheets were held in Western Australia (prior to the formal establishment of a state herbarium) at the time of description, with the subsequent distribution of one sheet to NSW.
Notes: See discussion under *Phyllota barbata* above.
Pultenaea benthamii F. Muell., *Definitions of rare or hitherto undescribed Australian plants* 5 (1855).
Type: amongst rocks on the top of Mount Abrupt, *F. Mueller s.n.* (lecto, designated by R.P.J. de Kok & J.G. West, *Australian Systematic Botany* 17(3): 276 (2004), K 000118882); isolecto: BM 000544575, MEL 567120, TCD 0014523).
Pultenaea benthamii var. *elatior* Benth. *Fl. Austral.* 2: 114 (1864).
Type citation: 'Yowaka river, and foot of mount William, F. Mueller.'
Type: Yowaka River, New South Wales, Apr. 1860, *F. Mueller s.n.* (lecto, here designated: K 000119047; isolecto: MEL 567122). *Residual syntypes*: Foot of Mount William, Nov. 1853, *F. Mueller s.n.* (K; MEL 567121, MEL 567123, ?MEL 627862) [= *Pultenaea humilis* Benth. ex Hook.f.].

Notes: de Kok & West [93] noted that var. *elatior* was based on two collections representing two taxa. We here choose a lectotype which places the variety as a synonym of *P. benthamii*, while the residual syntype represents *P. humilis*.
Pultenaea elusa (J.D. Briggs & Crisp) R.L. Barrett & Clugston, *comb. et stat. nov*.
Basionym: *Pultenaea parrisiae* subsp. *elusa* J.D. Briggs & Crisp, *Telopea* 5: 652 (1994).
Type: New South Wales: Central Tablelands: Wingello in swamps, 30 Sep 1938, *W.F. Blakely s.n.* (holo: NSW 38321).
Pultenaea elusa de Kok & J.G. West, *Austral. Syst. Bot*. 17: 288 (2004), *nom. inval*.
Note: de Kok and West [93] attempted to raise *Pultenaea parrisiae* subsp. *elusa* to the species rank, however they unfortunately cited the entire page range of the publication, so the combination was not validly published (ICN Article 41.5 [181]). We therefore provide a valid combination here.
Pultenaea recurvifolia (Benth.) H.B. Will., *Proceedings of the Royal Society of Victoria* ser. 2, 33: 146, pl. VI (1921); *Pultenaea tenuifolia* var. *recurvifolia* Benth., *Fl. Austral.* 2: 140 (1864).
Type citation: 'Near Portland, *Allitt*.'
Type: Cape Nelson, near Portland, Victoria, *W. Allitt s.n.* (lecto, here designated: MEL 2057338; isolecto: BM 000544779, K 000118046, K 000118047, NSW 38979).
Typification: Bentham had two collections available on loan from MEL, but only cited one collection (Near Portland, *Allitt*) [62], with two sheets now located at K and two other sheets at BM and MEL. Only the sheet at MEL bears the name 'var. *recurvifolia*', but this does not appear to be in Bentham's script, though, unfortunately, the bottom of the label has been cut off at some point. The sheets at BM and K bear the name *P. recurvifolia*, indicating that they were distributed much later. For this reason, we choose the MEL sheet as lectotype. A second collection (Mouth of the Glenelg [River], *W. Allitt s.n.* (K 000118045)) was annotated as the 'holotype' by M.D. Crisp in 1982, but it was not cited by Bentham [62], so it has no type status.
Notes: de Kok & West [94] erroneously treated this taxon as a synonym of *P. daltonii*, a later name. Further investigation has shown that *P. recurvifolia* is more closely allied to *P. hispidula* R.Br. ex Benth., as noted in *VicFlora* ([133], updated by Stajsic 2019). Its taxonomic status requires further investigation, and it is uncertain whether the taxon should be reinstated or included as a synonym of *P. hispidula*.
Stonesiella Crisp & P.H. Weston in M.D. Crisp *et al*., *Taxon* 48(4): 711 (1999). *Type*: *Stonesiella selaginoides* (Hook.f.) Crisp & P.H. Weston
Urodon Turcz., *Bulletin de la Societe Imperiale des Naturalistes de Moscou* 22(3): 16 (1849). *Type*: *Urodon capitatus* Turcz.
Mirbelieae s.l.
Daviesia Sm., *Transactions of the Linnean Society of London* 4: 220 (1798). *Type*: *Daviesia acicularis* Sm., designated by J. Hutchinson, *Dicotyledones*. *The Genera of Flowering Plants* (*Angiospermae*) 1: 339 (1964).
Erichsenia Hemsl., *Hooker's Icones Plantarum* 28: t. 2777 (1905). *Type*: *Erichsenia uncinata* Hemsl.
Gompholobium Sm., *Transactions of the Linnean Society of London* 4: 220 (1798). *Type*: *Gompholobium grandiflorum* Sm., designated by J.A. Chappill *et al*., *Australian Systematic Botany* 21(2): 68 (2008).
Burtonia R.Br. in W.T. Aiton, *Hortus Kewensis* Edn. 2, 3: 12 (1811), *nom. cons*., *non* Salisb. (1807), *nom. rej. Weihea* Rchb., *Conspectus Regni Vegetabilis* 212^{b} (1828), *nom. illeg*., *non* Sprengel (1825), *nom. rej. Type*: *Burtonia scabra* (Smith) W.T. Aiton
Gompholobium sect. *Disporaea* F. Muell., *Fragmenta Phytographiae Australiae* 3(18): 29 (1862), *nom. inval*., *nom. nud*.
Isotropis Benth. in S.F.L. Endlicher *et al*., *Leguminosae. Enumeratio plantarum quas in Novae Hollandiae ora austro-occidentali ad fluvium Cygnorum et in Sinu Regis Georgii collegit Carolus liber baro de Hügel* 28 (1837). *Type*: *Isotropis striata* Benth. [= *I. cuneifolia* (Sm.) Walp.].
Notes: Bentham [59] described two species in his new genus *Isotropis*, *I. biloba* Benth. and *I. striata* Benth. but did not designate either as the type as this was not a practice at the time.

Bentham [62] recognised *I. striata* as a good species, but included *I. biloba* as a synonym, having examined a broader range of specimens since his original treatment. On that basis, we here designate *I. striata* as the type of the genus.

The application of both names has been considered uncertain in Australian literature, but one of us (MDC) examined the type material of each taxon at W in 1982, and these specimens have recently become available online. They are both confirmed as synonyms of *I. cuneifolia*, as indicated by Bentham ([62]; as *Callistachys cuneifolia* Sm.). Both names are applicable to *I. cuneata* subsp. *cuneata* based on the characters defined by Keighery [113], though this taxon is variable and additional taxa are likely to be recognised.

Sphaerolobium Sm. in K.D.E. Koenig, & J. Sims (eds), *Annals of Botany* 1(3): 509 (1805). *Type*: *Sphaerolobium vimineum* Sm.

Roea Hügel ex Benth. in S.F.L. Endlicher *et al*., *Leguminosae. Enumeratio plantarum quas in Novae Hollandiae ora austro-occidentali ad fluvium Cygnorum et in Sinu Regis Georgii collegit Carolus liber baro de Hügel* 34 (1837). *Sphaerolobium* sect. *Roea* (Hügel ex Benth.) Benth., *Flora Australiensis* 2: 63, 64 (1864). *Type*: *Roea linophylla* Hügel ex Benth. [= *Sphaerolobium linophyllum* (Hügel ex Benth.) Benth.].

Viminaria Sm. in K.D.E. Koenig, & J. Sims (eds), *Annals of Botany* 1(3): 507 (1805). *Type*: *Viminaria denudata* Sm., *nom. illeg*. [= *V. juncea* (Schrad. & J.C. Wendl.) Hoffmanns.].

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