

# Taxonomic studies in *Tephrosia* Pers. (Fabaceae) in northern Western Australia

Final Report for Rio Tinto Pty Ltd – MesaA Terrestrial Offset Project



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## *Executive summary*

*Tephrosia* Pers. is a pantropically distributed, species-rich genus of pea-flowered legumes, comprising 75 named and 65 unnamed native taxa in Australia, according to the *Australian Plant Census*. This is considered an underestimate of real species numbers in Australia, and taxonomic work is ongoing at the Queensland Herbarium (BRI), Northern Territory Herbarium (DNA) and Western Australian Herbarium (PERTH) towards the discovery and documentation of its species.

At the commencement of this project there was little confidence in the application of names to specimens collected from across Western Australia (WA), especially those from the Eremaean, a region for which no formal taxonomic study into the genus had been performed (cf. a treatment of the genus for *Flora of the Kimberley Region* in 1992). There was therefore little certainty for botanical consultants and industry personnel about the identity or conservation status of any *Tephrosia* collected during development applications or environmental impact assessments in the Pilbara region. This has been the driver for the taxonomic research undertaken during this project, in which complexes in the Pilbara region and the broader Eremaean were targeted for study.

When this project started in 2011 there were 34 described and 16 undescribed (11 phrase-named; 5 manuscript-named) taxa on the WA vascular plant census, and 75% of the *Tephrosia* specimens at PERTH had been acquired since 1998, the year in which 75% of the original collection had gone out on loan (764 specimens). The absence of descriptions or identification tools for close to 50% of the taxa in WA, combined with a poorly curated collection in which there was little cohesiveness in taxon concepts and clearly more than one taxon within the majority of species folders, made the accurate identification of most taxa difficult. This project facilitated the return of the PERTH loan and collaborative study of the PERTH collection with specialist Ian Cowie (DNA), as well as visits to DNA to work with Cowie and BRI to work with specialist Les Pedley, to delimit the taxa occurring in WA and those shared between the States and Territory.

Over the course of the project this has led to the clarification of numerous species boundaries, the identification and reconciliation of 19 instances of informal synonymy (in which the same undescribed taxa were known by different names across Australia), the removal of two names from the WA plant census after research determined that those taxa did not occur in WA, the addition of 22 names, 17 of which are new, undescribed taxa for the State, and the formal description of one species, so far. These changes are summarised in Tables A and B in this summary, and details given in the report.

This report details the outcomes of taxonomic research into complexes occurring in the Pilbara and Eremaean, and provides taxonomic descriptions, images (where available), and discussions of habitat, phenology and affinities for all the undescribed taxa (29; Table C) currently known from across WA. Three recircumscribed species, from which new taxa have been segregated, are also described and discussed. Further research on the genus, including resolution of the *T. rosea* Benth. complex and production of a key to *Tephrosia* Australia-wide, is being conducted (2017–2020) under an Australian Biological Resources Study grant.

**Table A.** Informal synonymies between the Western Australian (PERTH), Northern Territory (DNA/NT) and Queensland (BRI) Herbaria identified or hypothesised during the course of this study. Key to symbols and formatting in this table: ! WA; \* WA+NT; ^ WA+NT+Qld; # NT+Qld; × NT+Qld+SA; ? unsure; italicised names in inverted commas ('x') are Pedley ms or *in sched.* names in use at BRI only. The following symbols and abbreviations are defined in the report's Glossary: ≡, ms, *in sched.*, *p.p.*, *s. lat.*

| Dist <sup>n</sup> | PERTH                                                                                                                                                                                  | DNA/NT                                                                                       | BRI                                                                                                               |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| *                 | <i>T. sp. B Kimberley Flora</i> (C.A. Gardner 7300)                                                                                                                                    | <i>T. sp. Katherine</i> (H.S. McKee 8509)                                                    | -                                                                                                                 |
| ?                 | <i>T. sp. C Kimberley Flora</i> (K.F. Kenneally 5599)                                                                                                                                  | ? [ <i>T. aff. sp. sparse pinnae</i> from Gulf country; not seen or studied, status unknown] | <i>T. sp. Mt Isa</i> (P.L. Harris 277) [ <i>p.p.</i> ]<br>+ <i>T. 'sparsifolia'</i> [ <i>p.p.</i> ]               |
| #                 | <i>T. sp. D Kimberley Flora</i> (R.D. Royce 1848)                                                                                                                                      | <i>T. sp. Barrow Creek</i> (G.M. Chippendale 921)                                            | <i>T. sp. Barrow Creek</i> (J. Egan 1800)<br>+ poorly defined <i>T. benthamii</i> Pedley                          |
| * ?               | <i>T. sp. E Kimberley Flora</i> (C.A. Gardner 9937)                                                                                                                                    | <i>T. sp. Crowded pinnae</i> (C.R. Dunlop 8202)                                              | [occurrence in Qld uncertain]                                                                                     |
| *                 | <i>T. sp. F Kimberley Flora</i> (B.R. Maslin 5139)                                                                                                                                     | <i>T. sp. Sinuate</i> (T.G. Hartley 14337)                                                   | -                                                                                                                 |
| !                 | <i>T. sp. Fortescue</i> (A.A. Mitchell 606)<br>[ <i>T. densa</i> Pedley ms]                                                                                                            | <i>T. sp. dense</i> (A.C. Beauglehole 11456), <i>in sched.</i>                               | -                                                                                                                 |
| *                 | <i>T. sp. G Kimberley Flora</i> (G.J. Keighery 4828)                                                                                                                                   | <i>T. sp. Crows foot</i> (I.C. Cowie 8562)                                                   | -                                                                                                                 |
| ^                 | <i>T. sp. Dunes</i> (J.R. Maconochie 938)<br>+ <i>T. roycei</i> Pedley ms, <i>in sched.</i>                                                                                            | <i>T. sp. Dunes</i> (J.R. Maconochie 938)                                                    | <i>T. sp. Tanami Desert</i> (P.K. Latz 11978) + <i>T. 'tanamiensis'</i>                                           |
| ×                 | [ <i>T. clelandii</i> Pedley ms on census; now excluded]<br>[ <i>T. aff. clelandii</i> ≡ <i>T. supina p.p.</i> ]                                                                       | <i>T. sp. Granite</i> (P.K. Latz 12116)                                                      | <i>T. sp. Balcanoona Creek</i> (K. Alcock AQ457802)<br>+ <i>T. 'clelandii'</i> + <i>T. 'latzii'</i>               |
| !                 | <i>T. rosea</i> var. <i>Port Hedland</i> (A.A. George 1114)<br>[ <i>T. rosea</i> var. <i>venulosa</i> Pedley ms]<br>[ <i>T. sp. Finucane Island</i> (G. Craig 269), <i>in sched.</i> ] | -                                                                                            | <i>T. sp. Finucane Island</i> (R. Story 8206)<br>+ <i>T. 'storyii'</i>                                            |
| !                 | <i>T. gardneri</i> Pedley ms                                                                                                                                                           | -                                                                                            | <i>T. sp. Carnarvon</i> (J.H. Ross 2681)<br>+ <i>T. 'ovaria'</i>                                                  |
| !                 | <i>T. sp. Onslow</i> (K.R. Newbey 10571)<br>+ <i>T. morrisonii</i> Pedley ms, <i>in sched.</i>                                                                                         | -                                                                                            | <i>T. sp. Carnarvon</i> (J.H. Ross 2681)<br>+ <i>T. 'ovaria'</i>                                                  |
| ^                 | <i>T. sp. Pentecost River</i> (I.D. Cowie 4168)                                                                                                                                        | <i>T. sp. Pentecost River</i> (I.D. Cowie 4168)                                              | <i>T. phaeosperma</i> var. <i>Westmoreland</i> (S. Melville 967)<br>+ <i>T. phaeosperma</i> var. ' <i>minor</i> ' |
| ^                 | <i>T. supina s. lat. 'central' form</i>                                                                                                                                                | <i>T. supina s. lat. 'central' form</i>                                                      | <i>T. 'centralis'</i>                                                                                             |
| ^                 | <i>T. sp. O.T. Station</i> (S.T. Blake 17659)                                                                                                                                          | <i>T. sp. O.T. Station</i> (S.T. Blake 17659)                                                | <i>T. sp. Magazine Hill</i> (P. Jones 365)<br>+ <i>T. 'carpentariae'</i>                                          |
| ^                 | <i>T. sp. Willowra</i> (G.M. Chippendale 4809)                                                                                                                                         | <i>T. sp. Willowra</i> (G.M. Chippendale 4809)                                               | <i>T. 'quinquefolia'</i>                                                                                          |
| ^ ?               | <i>T. rosea</i> 'Halls Creek' form                                                                                                                                                     | <i>T. rosea</i> 'Halls Creek' form                                                           | <i>T. sp. Adels Grove</i> (A. de Lestang 359)<br>+ <i>T. 'argyrea'</i>                                            |
| *                 | <i>T. rosea</i> 'short inflorescences' form                                                                                                                                            | <i>T. sp. Mistake Creek</i> (A.C. Beauglehole 54424)                                         | -                                                                                                                 |
| # / ^ ?           | [collected @ Kiwirrkurra in 2015?; under study]                                                                                                                                        | <i>T. rosea</i> 'deserts' form                                                               | <i>T. sp. Glenormiston</i> (R.W. Purdie 1362)<br>+ <i>T. 'deserti'</i>                                            |

**Table B.** Summary of changes to the Western Australian vascular plant census resulting from this project. Year = year change recorded on the census. > and < indicate replacement names through *Australian Plant Census* (APC) protocols and taxonomic synonymy, including formal publication.

| Year | Names added<br>(new taxa)         | Names added<br>(taxa reinstated)      | Names added<br>(taxa now in WA)             | Names added<br>(nomenclature changes)   | Names removed<br>(reason given)                                  |
|------|-----------------------------------|---------------------------------------|---------------------------------------------|-----------------------------------------|------------------------------------------------------------------|
| 2012 | <i>T. sp.</i> clay soils          | <i>T. filipes</i> var. <i>filipes</i> | <i>T. brachyodon</i> var. <i>longifolia</i> | <i>T. sp.</i> Fortescue >               | < <i>T. densa</i> ms [APC]                                       |
|      | <i>T. sp.</i> Dunes               | <i>T. stuartii</i>                    |                                             | <i>T. sp.</i> Carnarvon >               | < <i>T. gardneri</i> ms [APC]                                    |
|      | <i>T. sp.</i> Kennedy Range       |                                       |                                             | <i>T. rosea</i> var. Fortescue Creeks > | < <i>T. rosea</i> var. <i>glabrior</i> ms                        |
|      | <i>T. sp.</i> Kununurra           |                                       |                                             |                                         | <i>T. sp.</i> Crowded pinnae [≡ <i>T. sp.</i> E Kimberley Flora] |
|      | <i>T. sp.</i> Onslow              |                                       |                                             |                                         | <i>T. bidwillii</i> [excluded, not in WA]                        |
|      | <i>T. sp.</i> Pilbara             |                                       |                                             |                                         |                                                                  |
|      | <i>T. sp.</i> Saw Ranges          |                                       |                                             |                                         |                                                                  |
| 2013 | <i>T. rosea</i> var. Napier Range |                                       |                                             | <i>T. rosea</i> var. Port Hedland >     | < <i>T. rosea</i> var. <i>venulosa</i> ms [APC]                  |
|      | <i>T. sp.</i> Central             |                                       |                                             | <i>T. oxalidea</i> >                    | < <i>T. sp.</i> Cathedral Gorge [taxon published]                |
|      | <i>T. sp.</i> Mistake Creek       |                                       |                                             |                                         | <i>T. sp.</i> Pilbara [≡ <i>T. supina</i> s. str.]               |
|      | <i>T. sp.</i> Newman              |                                       |                                             |                                         | <i>T. clelandii</i> ms [excluded, not in WA]                     |
|      | <i>T. sp.</i> Northern            |                                       |                                             |                                         |                                                                  |
|      | <i>T. sp.</i> NW Eremaean         |                                       |                                             |                                         |                                                                  |
| 2014 | <i>T. sp.</i> deserts             |                                       |                                             |                                         |                                                                  |
|      | <i>T. sp.</i> Yampi               |                                       |                                             |                                         |                                                                  |
| 2015 | <i>T. sp.</i> Willowra            |                                       |                                             |                                         |                                                                  |
| 2016 | <i>T. sp.</i> North West Cape     |                                       |                                             |                                         |                                                                  |
| 2017 |                                   |                                       |                                             | <i>T. sp.</i> Magazine Hill >           | < <i>T. sp.</i> O.T. Station [APC]                               |



**Table C.** The known described and undescribed *Tephrosia* taxa occurring in Western Australia, indicating their distributions in the Eremaean and Northern Botanical Provinces. Taxa marked with # also occur outside WA. Taxa marked with <sup>P</sup> are found in or immediately adjacent to the Pilbara region.

| <b>Eremaean only</b>                               | <b>Eremaean &amp; Northern</b>                     | <b>Northern only</b>                          |
|----------------------------------------------------|----------------------------------------------------|-----------------------------------------------|
| <i>T. arenicola</i>                                | <i>T. brachycarpa</i> #                            | <i>T. andrewii</i>                            |
| <i>T. clementii</i> <sup>P</sup>                   | <i>T. leptoclada</i> <sup>P</sup> #                | <i>T. brachyodon</i> var. <i>longifolia</i> # |
| <i>T. oxalidea</i> <sup>P</sup>                    | <i>T. rosea</i> var. <i>clementii</i> <sup>P</sup> | <i>T. conspicua</i>                           |
| <i>T. rosea</i> var. Fortescue creeks <sup>P</sup> | <i>T. rosea</i> var. <i>rosea</i> <sup>P</sup>     | <i>T. coriacea</i>                            |
| <i>T. rosea</i> var. Port Hedland <sup>P</sup>     | <i>T. simplicifolia</i> #                          | <i>T. crocea</i>                              |
| <i>T. sphaerospora</i> #                           | <i>T. stipuligera</i> <sup>P</sup> #               | <i>T. filipes</i> var. <i>filipes</i> #       |
| <i>T. supina</i> <sup>P</sup>                      | <i>T. virens</i> <sup>P</sup> #                    | <i>T. flammea</i> var. <i>monophylla</i>      |
| <i>T. uniovulata</i>                               | <i>T. sp. B Kimberley Flora</i> <sup>P</sup> #     | <i>T. forrestiana</i>                         |
| <i>T. sp. Carnarvon (+Onslow)</i>                  | <i>T. sp. Bungaroo Creek</i> <sup>P</sup> #        | <i>T. lasiochlaena</i>                        |
| <i>T. sp. Central</i> #                            | <i>T. sp. C Kimberley Flora</i>                    | <i>T. laxa</i> var. <i>angustata</i>          |
| <i>T. sp. clay soils</i> <sup>P</sup>              | <i>T. sp. D Kimberley Flora</i> <sup>P</sup> #     | <i>T. macrocarpa</i>                          |
| <i>T. sp. Dunes</i> #                              | <i>T. sp. Northern</i> <sup>P</sup> #              | <i>T. oblongata</i>                           |
| <i>T. sp. deserts</i> <sup>P</sup> #               |                                                    | <i>T. phaeosperma</i> #                       |
| <i>T. sp. Fortescue (+Meentheena)</i> <sup>P</sup> |                                                    | <i>T. polyzyga</i>                            |
| <i>T. sp. Kennedy Range</i>                        |                                                    | <i>T. procera</i>                             |
| <i>T. sp. Magazine Hill</i> #                      |                                                    | <i>T. remotiflora</i>                         |
| <i>T. sp. Newman</i> <sup>P</sup>                  |                                                    | <i>T. rosea</i> var. Napier Range             |
| <i>T. sp. North West Cape</i>                      |                                                    | <i>T. spechtii</i>                            |
| <i>T. sp. NW Eremaean</i> <sup>P</sup>             |                                                    | <i>T. stuartii</i>                            |
| <i>T. sp. Willowra</i> <sup>P</sup> #              |                                                    | <i>T. subpectinata</i> #                      |
|                                                    |                                                    | <i>T. valleculata</i>                         |
|                                                    |                                                    | <i>T. sp. E Kimberley Flora</i> #             |
|                                                    |                                                    | <i>T. sp. F Kimberley Flora</i>               |
|                                                    |                                                    | <i>T. sp. G Kimberley Flora</i> #             |
|                                                    |                                                    | <i>T. sp. Kununurra</i> #                     |
|                                                    |                                                    | <i>T. sp. Mistake Creek</i>                   |
|                                                    |                                                    | <i>T. sp. Pentecost River</i> #               |
|                                                    |                                                    | <i>T. sp. Saw Ranges</i>                      |
|                                                    |                                                    | <i>T. sp. sparse pinnae</i> #                 |
|                                                    |                                                    | <i>T. sp. Yampi</i>                           |
| <b>6 described</b>                                 | <b>7 described</b>                                 | <b>20 described</b>                           |
| <b>12 undescribed</b>                              | <b>5 undescribed</b>                               | <b>10 undescribed</b>                         |
| <b>All Eremaean = 30 (13 d; 17 u)</b>              |                                                    | <b>All Northern = 42 (27 d; 15 u)</b>         |

## ***Background and scope of project***

### ***Need for the study***

The legume genus *Tephrosia* Pers. is pantropically distributed with extension into adjacent semi-arid and arid areas, and in Australia the genus is widely distributed across the tropics, monsoon tropics and red centre. The number of species of *Tephrosia* world-wide has been estimated at 300–400 (Lewis *et al.* 2005); however, Pedley (2014) noted that his studies of the genus in eastern Australia suggest that there are up to three times as many undescribed as described species there. It is the second largest legume genus in Australia behind *Acacia* Mill.

The need for taxonomic revision in *Tephrosia* Australia-wide has been long recognised, with research by Alma Lee (NSW, dec.) and Les Pedley (BRI) beginning in earnest in the 1970s. At that time the state of knowledge of *Tephrosia* was parlous; most types being held overseas, the correct application of names to the increasing number of increasingly diverse specimens was nigh-on impossible. Lee is credited for her detailed examination of types at K and MEL and her written accounts of them, allowing many taxa to be correctly identified for the first time. Pedley is credited for his long-running revisionary work, including investigation and clarification of the generic boundary of *Tephrosia* and foundational work on patterns of diversity within the genus, as well as his taxonomy.

This situation was echoed in Western Australia (WA), where there was little confidence in the application of names to the specimens at PERTH, resulting from an absence of specialist knowledge in the group. Treatment of *Tephrosia* for *Flora of the Kimberley Region* (Wheeler 1992) highlighted the difficulty in ascribing names to taxa (e.g. four of the 20 named species treated have misapplied names) and the large number of regionally new taxa in the genus (*Tephrosia* spp. A–G were recognised; 26% of the treated taxa, but really 37% because three of the misapplied names were used for currently undescribed taxa). There was much lower confidence in identifying taxa from the Eremaean, a region for which no taxonomic study had been undertaken, bar Maconochie's (1980, 1981).

In response to the need for revision of the genus in the Northern Territory (NT) and the known cross-over in species between the NT and the Kimberley, Ian Cowie (DNA) loaned over three-quarters of the PERTH *Tephrosia* collection in 1998 (764 specimens loaned), leaving 228 specimens to represent all the taxa (50 on the vascular plant census) in WA. Using these loaned specimens, Cowie described four new species for WA (including transfer of *Paratephrosia lanata* (Benth.) Domin to *Tephrosia* as *T. lasiochlaena* Cowie), concentrating on orange-flowered taxa with reticulate intersecondary venation on leaflets (Cowie 2004). In addition to formally describing Wheeler's *Tephrosia* sp. A as *T. procera* Cowie (Cowie 2004), Cowie earmarked *T.* sp. F and *T.* sp. G for publication; both of these also occur in the NT, but neither have been formally described to date.

Prior to and during the Pilbara Region Biological Survey, numerous specimens of interest were sent to Cowie for identification, with these forming the basis for understanding species concepts in WA. Despite this flow of information the consistency of

identifications within many species' specimen folders deteriorated as new collections were matched to those that had already been mis-identified, etc. etc. *ad nauseum*. For each new specimen contributor, the task of correctly identifying a species became more difficult, having a profound impact on the accuracy of development proposals and environmental impact assessments in the Pilbara region. Many environmental consultants developed their own informal taxonomies to account for the variation seen in the field, with these concepts and names proliferating in the grey literature, including reports to industry. Revisionary work on *Tephrosia* in north-west WA was thus proposed as a priority area for funding under Rio Tinto Pty Ltd's Mesa A Terrestrial Offset programme.

### *The study*

At the commencement of the study, 34 described and 16 undescribed taxa (11 phrase names + five manuscript (ms) names) were recognised as occurring in WA. It was difficult to define species or identify specimens with any accuracy because of the state of the PERTH *Tephrosia* collection; 762 specimens had been added since 1998, meaning that *c.* 75% of the existing (2011) collection had been amassed while *c.* 75% of the original collection (to 1998) had been on loan. A 'blank canvas' approach was therefore taken, whereby the 990 specimens in the collection were sorted on their morphology, with specimens previously identified by Pedley or Cowie used to guide the application of names to groups of specimens. To progress the revision, expert input was required and it was arranged for Cowie to visit PERTH on a two week sabbatical to study the collection with Ryonen Butcher, so as to confirm the identities of named taxa, assist in the identification of putatively new taxa, and to discuss patterns of infraspecific variation. Cowie was encouraged to return the PERTH loan at the same time so that the full range of variation in each species would be evident for further revisionary study. This was successfully negotiated and the visit was extremely fruitful.

Collaborative study of the PERTH collection identified that five existing phrase names in use in WA had alternative phrase names in the NT. The different phrase names were reconciled under the WA names as part of the *Australian Plant Census* (APC) project. The WA names were selected over the NT names as a taxonomic key, some descriptive information and some illustrations were available in Wheeler (1992). Reconciliation of the names made it possible to communicate about each of these taxa and improved the accuracy of the *Australasian Virtual Herbarium* (AVH; formerly *Australia's Virtual Herbarium*), which draws its mapping data from the specimen databases of all the Australian and New Zealand herbaria. Collaborative study also led to 10 names being added to the WA plant census. These included seven new phrase names, representing new undescribed taxa, and three names of already-described taxa, which were recognised as also occurring in WA. A phrase name was also removed as it was found PERTH had two informal names for the one taxon.

Field trips to the Carnarvon, Gascoyne and Pilbara bioregions allowed taxon concepts to be solidified, type material to be collected, and another new taxon to be recognised and added to the census as a phrase name. Visits to two interstate herbaria were undertaken to

study their collections, annotate specimens and correct identifications, and organise specimens for loan to PERTH (MEL: 249 specimens; NSW: 79 specimens). A large loan of 253 specimens, including 84 essential type specimens, was also organised from K. The ongoing study of specimens permitted a phrase-named species on the plant census (*T. sp.* Cathedral Gorge) to be formally described as *T. oxalidea* Butcher & P.J.H.Hurter (Butcher & Hurter 2012).

Because *Tephrosia* is such a large and diverse genus, Cowie and Pedley have each focussed on one of the two major groups within it, the yellow or orange-flowered species (Cowie) and the (sometimes white) pink to purple-flowered species (Pedley), each developing expertise that has become somewhat siloed. In order to gain an understanding of the whole WA *Tephrosia* flora, a joint visit (by Cowie and Butcher) was undertaken to BRI to work alongside Pedley for two weeks. Unfortunately he was taken ill and was not available as much as hoped, but did allow full access to the *Tephrosia* collection as well as some notes on his putatively new taxa.

As with Cowie's visit to PERTH, this collaborative study had excellent taxonomic outcomes, allowing the reconciliation of an additional 12 informal names across the WA/NT/Qld borders. Some forms that had been identified within variable species at PERTH were found to have phrase names at BRI. The considerable confusion associated with having different informal names for the same taxon was exacerbated at BRI, where the majority of informally-recognised taxa have two informal names each—a phrase name and a manuscript name—both of which are in common use there. Some taxa were each known by a phrase name and two manuscript names, one of which was no longer in common use at BRI but still appeared on specimens and specimen folders. A summary of the reconciliation of informal names relevant to the taxonomy of *Tephrosia* in WA is provided in Table 1. Through the visit it was possible to add one name (*T. sp.* Mistake Creek) and remove two names from the WA plant census—*T. clelandii* Pedley ms was found to be misapplied against a miscellany of PERTH material, and *T. bidwillii* Benth. was discovered to only occur in Qld and NSW; this was confirmed through field work and the findings were published (Butcher 2012). Numerous BRI specimens were annotated and a loan to PERTH of 318 specimens was also organised.

The visit to BRI and a follow-up visit to DNA, to examine their collections of taxa that occur in WA, made it possible for the name *T. supina* Domin to be correctly applied within Australia for the first time since its description (Domin 1926). This has had implications across Australia and is discussed in detail below. Continued study of PERTH and loaned specimens has resulted in another 11 phrase names being added to the WA plant census, and two being removed. These changes are summarised in this report.

At this point in time, 60 *Tephrosia* taxa are known from WA, with this number undoubtedly increasing in the future. Close to half (45%) of the taxa known from WA do not have formal names or published descriptions. This value is higher than for the NT (see <http://eflora.nt.gov.au/>) where their plant census shows that nearly 34% of their 65 taxa are known by phrase names. Current *Australian Plant Census* data for *Tephrosia* from Qld indicates that nearly 38% of their taxa are undescribed; however, anecdotal evidence (based on examining the annotated collection at BRI and communications with

Pedley) suggests that the proportion is much higher. Based on his studies of *Tephrosia* in eastern Australia, Pedley (2014) has hypothesised that there are up to three times as many undescribed species as there are already described species; theoretically, the proportion of taxa that are currently unnamed could therefore approximate 75%.

Within WA *Tephrosia* is distributed across the Eremaean and Northern Botanical Provinces (*sensu* Beard 1990), with more taxa known from the Northern (42 vs 30) and fractionally more (17 vs 15) undescribed taxa known from the Eremaean (Table 2). The Eremaean does have proportionally more undescribed taxa, with nearly 57% of all taxa found there not having a formal name (vs nearly 36% in the Northern); however, this probably reflects the taxonomic effort expended on the region's flora recently.



**Table 1.** Informal synonymies between the Western Australian (PERTH), Northern Territory (DNA/NT) and Queensland (BRI) Herbaria identified or hypothesised during the course of this study. Key to symbols and formatting in this table: ! WA; \* WA+NT; ^ WA+NT+Qld; # NT+Qld; × NT+Qld+SA; ? unsure; italicised names in inverted commas ('x') are Pedley ms or *in sched.* names in use at BRI only. The following symbols and abbreviations are defined in the Glossary: ≡, ms, *in sched.*, *p.p.*, *s. lat.*

| Dist <sup>n</sup> | PERTH                                                                                                                                                                           | DNA/NT                                                                                       | BRI                                                                                                 |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| *                 | <i>T. sp. B Kimberley Flora</i> (C.A. Gardner 7300)                                                                                                                             | <i>T. sp. Katherine</i> (H.S. McKee 8509)                                                    | -                                                                                                   |
| ?                 | <i>T. sp. C Kimberley Flora</i> (K.F. Kenneally 5599)                                                                                                                           | ? [ <i>T. aff. sp. sparse pinnae</i> from Gulf country; not seen or studied, status unknown] | <i>T. sp. Mt Isa</i> (P.L. Harris 277) [ <i>p.p.</i> ]<br>+ <i>T. 'sparsifolia'</i> [ <i>p.p.</i> ] |
| #                 | <i>T. sp. D Kimberley Flora</i> (R.D. Royce 1848)                                                                                                                               | <i>T. sp. Barrow Creek</i> (G.M. Chippendale 921)                                            | <i>T. sp. Barrow Creek</i> (J. Egan 1800)<br>+ poorly defined <i>T. benthamii</i> Pedley            |
| * ?               | <i>T. sp. E Kimberley Flora</i> (C.A. Gardner 9937)                                                                                                                             | <i>T. sp. Crowded pinnae</i> (C.R. Dunlop 8202)                                              | [occurrence in Qld uncertain]                                                                       |
| *                 | <i>T. sp. F Kimberley Flora</i> (B.R. Maslin 5139)                                                                                                                              | <i>T. sp. Sinuate</i> (T.G. Hartley 14337)                                                   | -                                                                                                   |
| !                 | <i>T. sp. Fortescue</i> (A.A. Mitchell 606)<br>[ <i>T. densa</i> Pedley ms]                                                                                                     | <i>T. sp. dense</i> (A.C. Beauglehole 11456), <i>in sched.</i>                               | -                                                                                                   |
| *                 | <i>T. sp. G Kimberley Flora</i> (G.J. Keighery 4828)                                                                                                                            | <i>T. sp. Crows foot</i> (I.C. Cowie 8562)                                                   | -                                                                                                   |
| ^                 | <i>T. sp. Dunes</i> (J.R. Maconochie 938)<br>+ <i>T. roycei</i> Pedley ms, <i>in sched.</i>                                                                                     | <i>T. sp. Dunes</i> (J.R. Maconochie 938)                                                    | <i>T. sp. Tanami Desert</i> (P.K. Latz 11978) + <i>T. 'tanamiensis'</i>                             |
| ×                 | [ <i>T. clelandii</i> Pedley ms on census; now excluded]<br>[ <i>T. aff. clelandii</i> ≡ <i>T. supina p.p.</i> ]                                                                | <i>T. sp. Granite</i> (P.K. Latz 12116)                                                      | <i>T. sp. Balcanoona Creek</i> (K. Alcock AQ457802)<br>+ <i>T. 'clelandii'</i> + <i>T. 'latzii'</i> |
| !                 | <i>T. rosea</i> var. Port Hedland (A.A. George 1114)<br>[ <i>T. rosea</i> var. <i>venulosa</i> Pedley ms]<br>[ <i>T. sp. Finucane Island</i> (G. Craig 269), <i>in sched.</i> ] | -                                                                                            | <i>T. sp. Finucane Island</i> (R. Story 8206)<br>+ <i>T. 'storyii'</i>                              |
| !                 | <i>T. gardneri</i> Pedley ms                                                                                                                                                    | -                                                                                            | <i>T. sp. Carnarvon</i> (J.H. Ross 2681)<br>+ <i>T. 'ovaria'</i>                                    |
| !                 | <i>T. sp. Onslow</i> (K.R. Newbey 10571)<br>+ <i>T. morrisonii</i> Pedley ms, <i>in sched.</i>                                                                                  | -                                                                                            | <i>T. sp. Carnarvon</i> (J.H. Ross 2681)<br>+ <i>T. 'ovaria'</i>                                    |
| ^                 | <i>T. sp. Pentecost River</i> (I.D. Cowie 4168)                                                                                                                                 | <i>T. sp. Pentecost River</i> (I.D. Cowie 4168)                                              | <i>T. phaeosperma</i> var. Westmoreland (S. Melville 967)<br>+ <i>T. phaeosperma</i> var. 'minor'   |
| ^                 | <i>T. supina s. lat.</i> 'central' form                                                                                                                                         | <i>T. supina s. lat.</i> 'central' form                                                      | <i>T. 'centralis'</i>                                                                               |
| ^                 | <i>T. sp. O.T. Station</i> (S.T. Blake 17659)                                                                                                                                   | <i>T. sp. O.T. Station</i> (S.T. Blake 17659)                                                | <i>T. sp. Magazine Hill</i> (P. Jones 365)<br>+ <i>T. 'carpentariae'</i>                            |
| ^                 | <i>T. sp. Willowra</i> (G.M. Chippendale 4809)                                                                                                                                  | <i>T. sp. Willowra</i> (G.M. Chippendale 4809)                                               | <i>T. 'quinquefolia'</i>                                                                            |
| ^ ?               | <i>T. rosea</i> 'Halls Creek' form                                                                                                                                              | <i>T. rosea</i> 'Halls Creek' form                                                           | <i>T. sp. Adels Grove</i> (A. de Lestang 359)<br>+ <i>T. 'argyrea'</i>                              |
| *                 | <i>T. rosea</i> 'short inflorescences' form                                                                                                                                     | <i>T. sp. Mistake Creek</i> (A.C. Beauglehole 54424)                                         | -                                                                                                   |
| # / ^ ?           | [collected @ Kiwirrkurra in 2015?; under study]                                                                                                                                 | <i>T. rosea</i> 'deserts' form                                                               | <i>T. sp. Glenormiston</i> (R.W. Purdie 1362)<br>+ <i>T. 'deserti'</i>                              |

**Table 2.** Distributions of the known taxa of *Tephrosia* in Western Australia, as of May 2017, in the Eremaean and Northern Botanical Provinces. Taxa marked with # also occur outside WA. Taxa marked with \* have been earmarked for description by I. Cowie (DNA) since the project's commencement. Taxa marked with <sup>P</sup> are found in or immediately adjacent to the Pilbara region.

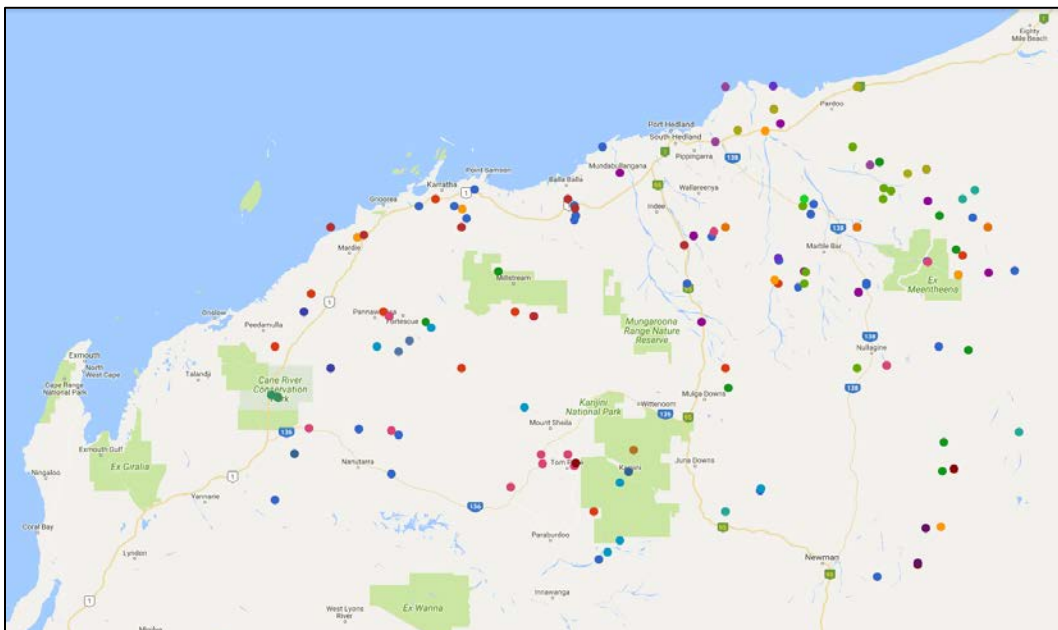
| <b>Eremaean only</b>                               | <b>Eremaean &amp; Northern</b>                     | <b>Northern only</b>                          |
|----------------------------------------------------|----------------------------------------------------|-----------------------------------------------|
| <i>T. arenicola</i>                                | <i>T. brachycarpa</i> #                            | <i>T. andrewii</i>                            |
| <i>T. clementii</i> <sup>P</sup>                   | <i>T. leptoclada</i> <sup>P</sup> #                | <i>T. brachyodon</i> var. <i>longifolia</i> # |
| <i>T. oxalidea</i> <sup>P</sup>                    | <i>T. rosea</i> var. <i>clementii</i> <sup>P</sup> | <i>T. conspicua</i>                           |
| <i>T. rosea</i> var. Fortescue creeks <sup>P</sup> | <i>T. rosea</i> var. <i>rosea</i> <sup>P</sup>     | <i>T. coriacea</i>                            |
| <i>T. rosea</i> var. Port Hedland <sup>P</sup>     | <i>T. simplicifolia</i> #                          | <i>T. crocea</i>                              |
| <i>T. sphaerospora</i> #                           | <i>T. stipuligera</i> <sup>P</sup> #               | <i>T. filipes</i> var. <i>filipes</i> #       |
| <i>T. supina</i> <sup>P</sup>                      | <i>T. virens</i> <sup>P</sup> #                    | <i>T. flammea</i> var. <i>monophylla</i>      |
| <i>T. uniovulata</i>                               | <i>T. sp. B Kimberley Flora</i> <sup>P</sup> #     | <i>T. forrestiana</i>                         |
| <i>T. sp. Carnarvon (+Onslow)</i>                  | <i>T. sp. Bungaroo Creek</i> <sup>P</sup> #        | <i>T. lasiochlaena</i>                        |
| <i>T. sp. Central</i> #                            | <i>T. sp. C Kimberley Flora</i>                    | <i>T. laxa</i> var. <i>angustata</i>          |
| <i>T. sp. clay soils</i> <sup>P</sup>              | <i>T. sp. D Kimberley Flora</i> <sup>P</sup> #     | <i>T. macrocarpa</i>                          |
| <i>T. sp. Dunes</i> *#                             | <i>T. sp. Northern</i> <sup>P</sup> #              | <i>T. oblongata</i>                           |
| <i>T. sp. deserts</i> <sup>P</sup> #               |                                                    | <i>T. phaeosperma</i> #                       |
| <i>T. sp. Fortescue (+Meentheena)</i> <sup>P</sup> |                                                    | <i>T. polyzyga</i>                            |
| <i>T. sp. Kennedy Range</i>                        |                                                    | <i>T. procera</i>                             |
| <i>T. sp. Magazine Hill</i> #                      |                                                    | <i>T. remotiflora</i>                         |
| <i>T. sp. Newman</i> <sup>P</sup>                  |                                                    | <i>T. rosea</i> var. Napier Range             |
| <i>T. sp. North West Cape</i>                      |                                                    | <i>T. spechtii</i>                            |
| <i>T. sp. NW Eremaean</i> <sup>P</sup>             |                                                    | <i>T. stuartii</i>                            |
| <i>T. sp. Willowra</i> <sup>P</sup> #              |                                                    | <i>T. subpectinata</i> #                      |
|                                                    |                                                    | <i>T. valleculata</i>                         |
|                                                    |                                                    | <i>T. sp. E Kimberley Flora</i> #             |
|                                                    |                                                    | <i>T. sp. F Kimberley Flora</i> *             |
|                                                    |                                                    | <i>T. sp. G Kimberley Flora</i> *#            |
|                                                    |                                                    | <i>T. sp. Kununurra</i> #                     |
|                                                    |                                                    | <i>T. sp. Mistake Creek</i>                   |
|                                                    |                                                    | <i>T. sp. Pentecost River</i> #               |
|                                                    |                                                    | <i>T. sp. Saw Ranges</i>                      |
|                                                    |                                                    | <i>T. sp. sparse pinnae</i> #                 |
|                                                    |                                                    | <i>T. sp. Yampi</i>                           |
| <b>6 described</b>                                 | <b>7 described</b>                                 | <b>20 described</b>                           |
| <b>12 undescribed</b>                              | <b>5 undescribed</b>                               | <b>10 undescribed</b>                         |
| <b>All Eremaean = 30 (13 d; 17 u)</b>              |                                                    | <b>All Northern = 42 (27 d; 15 u)</b>         |

## Research focus areas

### The Pilbara

The Eremaean Botanical Province of WA is a vast and arid region that is home to the greatest concentration of mining leases in the State, this is particularly pronounced in the Pilbara region. Botanical surveys associated with development proposals have in the past frequently encountered populations of *Tephrosia* that could not be readily identified, and which have proved an impediment to environmental impact assessments, especially as their conservation statuses were unknown. Because these surveys are frequently undertaken in areas that have not been explored, many collections made are taxonomically very interesting, representing end of range variation, significant range extensions, first collections for the State of taxa known elsewhere, or putatively new species. The high proportion of unresolved taxa and specimens of interest in the region has made it a priority for study.

In response to a need for systematically collected and analysed data on the biota of the Pilbara and correlations with landform, the Pilbara Region Biological Survey was undertaken by the then Department of Conservation and Land Management. During this survey 204 *Tephrosia* specimens were collected from across the Pilbara in a range of habitats (Figure 1), allowing for direct comparison of specimens collected during the same time periods. These collections have been instrumental for the resolution of boundaries in some difficult complexes. Through this project's research those 204 specimens have been found to represent 23 different taxa (Table 3).



**Figure 1.** Locations of the 204 *Tephrosia* collected made during the Pilbara Region Biological Survey. The 23 different taxa collected are colour coded by taxon to show spread across the region. Specimen data accessed through the *Australasian Virtual Herbarium* and visualised using the spatial portal tool in the *Atlas of Living Australia*.

Of interest is the high number of collections of *T. sp.* NW Eremaean, *T. sp.* clay soils and *T. supina*, none of which would have been correctly identified before this research was undertaken. The high frequency of their collection across the Pilbara, combined with the uncertain application of names and large amount of morphological variation, made '*T. supina*' and '*T. clementii*' research focus areas during this project. They are discussed in detail below, and an account is also given of the *T. rosea* complex, another highly problematic group within the Pilbara and beyond.

**Table 3.** Pilbara Biological Survey collections of *Tephrosia*, by frequency of collection. Twenty-three different taxa were collected, with twice as many *T. sp.* NW Eremaean specimens collected as any other taxon. At least 43% of specimens would have been mis-identified; 39% of taxa collected underwent taxonomic change: ^ resolved as new in this project, + recircumscribed, # resolved as not being distinct, \* novel/under review.

| Taxon                                                               | # specimens |
|---------------------------------------------------------------------|-------------|
| <i>Tephrosia sp.</i> NW Eremaean (S. van Leeuwen et al. PBS 0356) ^ | 44          |
| <i>Tephrosia sp.</i> clay soils (S. van Leeuwen et al. PBS 0273) ^  | 17          |
| <i>Tephrosia supina</i> +                                           | 17          |
| <i>Tephrosia rosea</i> var. <i>clementii</i>                        | 16          |
| <i>Tephrosia sp.</i> Bungaroo Creek (M.E. Trudgen 11601)            | 16          |
| <i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186)  | 12          |
| <i>Tephrosia sp.</i> Fortescue (A.A. Mitchell 606)                  | 12          |
| <i>Tephrosia virens</i>                                             | 11          |
| <i>Tephrosia clementii</i> +                                        | 8           |
| <i>Tephrosia rosea</i>                                              | 7           |
| <i>Tephrosia leptoclada</i>                                         | 6           |
| <i>Tephrosia arenicola</i>                                          | 5           |
| <i>Tephrosia sp.</i> D Kimberley Flora (R.D. Royce 1848)            | 5           |
| <i>Tephrosia sp.</i> [aff. <i>remotiflora</i> /Peedamulla] *        | 5           |
| <i>Tephrosia rosea</i> var. <i>rosea</i>                            | 4           |
| <i>Tephrosia sp.</i> Meentheena (S. van Leeuwen 4479) #             | 4           |
| <i>Tephrosia sp.</i> Newman (A.A. Mitchell PRP 29) ^                | 3           |
| <i>Tephrosia sp.</i> Northern (K.F. Kenneally 11950) ^              | 3           |
| <i>Tephrosia sp.</i> Onslow (K.R. Newbey 10571) #                   | 3           |
| <i>Tephrosia sp.</i> B Kimberley Flora (C.A. Gardner 7300)          | 2           |
| <i>Tephrosia uniovulata</i>                                         | 2           |
| <i>Tephrosia oxalidea</i>                                           | 1           |
| <i>Tephrosia simplicifolia</i>                                      | 1           |
|                                                                     | <b>204</b>  |

## *Tephrosia supina*

The concept of *T. supina* Domin. has long been confused Australia-wide and this is evident throughout the literature, where the flowers are variously described as pink/purple (Jessop & Toelken 1986)<sup>1</sup>, as orange (Maconochie 1981; Wheeler 1992; Paczowska & Chapman 2000; Harden 2002), or as both (Hacker 1990); the original description (Domin 1926) does not provide any flower colour information. The probable holotype of *T. supina* has now been viewed and the name confidently applied to a taxon occurring in the Pilbara and Gascoyne bioregions of WA. Two similar, purple-flowered segregate taxa have been confirmed as distinct from *T. supina*, namely *T. sp.* Willowra (G.M. Chippendale 4809) and *T. sp.* Magazine Hill (P. Jones 365) [*syn. T. sp.* O.T. Station (S.T. Blake 17659); CHAH 2016). A revised diagnostic description of *T. supina* and descriptions for these two phrase names are provided herein.

Because it was widely thought that *T. supina* was an orange-flowered taxon, and that was the view in WA also (Wheeler 1992; Paczowska & Chapman 2000), preliminary study of the entire complex in conjunction with Cowie had identified four putative taxa—‘*T. supina*’ (Pilbara form), ‘*T. supina*’ (Kimberley–NT form), ‘*T. supina*’ (central desert form), and *T. sp.* Pilbara (A.L. Payne PRP 1393), a pink/purple-flowered taxon that was thought to be a new species; that name has now been removed from the vascular plant census and is an informal synonym of *T. supina s. str.*

With the correct application of the name *T. supina* the various orange-flowered entities that had previously been included in *T. supina* became taxonomic orphans. Specimens across all three of these orange-flowered segregate taxa had, at some stage, been identified as *T. eriocarpa* Benth. This name was formerly on the WA vascular plant census but excluded on advice from Cowie in 2004 who determined that the name had been misapplied in WA. Type material has been viewed and the name does not apply to any of these taxa; *T. eriocarpa* has not been collected from WA and PERTH does not hold any specimens. Thus, three phrase names—*T. sp.* NW Eremaean (S. van Leeuwen et al. PBS 0356), *T. sp.* Northern (K.F. Kenneally 11950) and *T. sp.* Central (P.K. Latz 17037)—were erected on the census to account for the three informal groups, respectively.

Their status was then investigated through phenetic analysis of specimens held at PERTH and on loan from BRI<sup>2</sup> and NSW. A total of 69 specimens (Appendix 1; 23 *T. sp.* Central, 29 *T. sp.* Northern, 2 *T. sp.* Northern/*T. sp.* Central intermediates, 15 *T. sp.* NW Eremaean) were scored for 32 characters, 25 of which were ultimately used in multivariate morphometric analyses (Appendix 1; 12 continuous, 3 ordinal, 5 ratio/proportions, 5 binary/multistate). Where possible, three replicate measures were taken for each character from each specimen and the average used in analyses. Calyx and

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<sup>1</sup> As *T. supina* does not occur in SA, it is not clear what they were referring to, but it is likely to be *T. sp.* Willowra (G.M. Chippendale 4809), or *T. sp.* Granite (P.K. Latz 12116).

<sup>2</sup> The barcodes of BRI herbarium sheets are prefixed with AQ; see Figure 2.

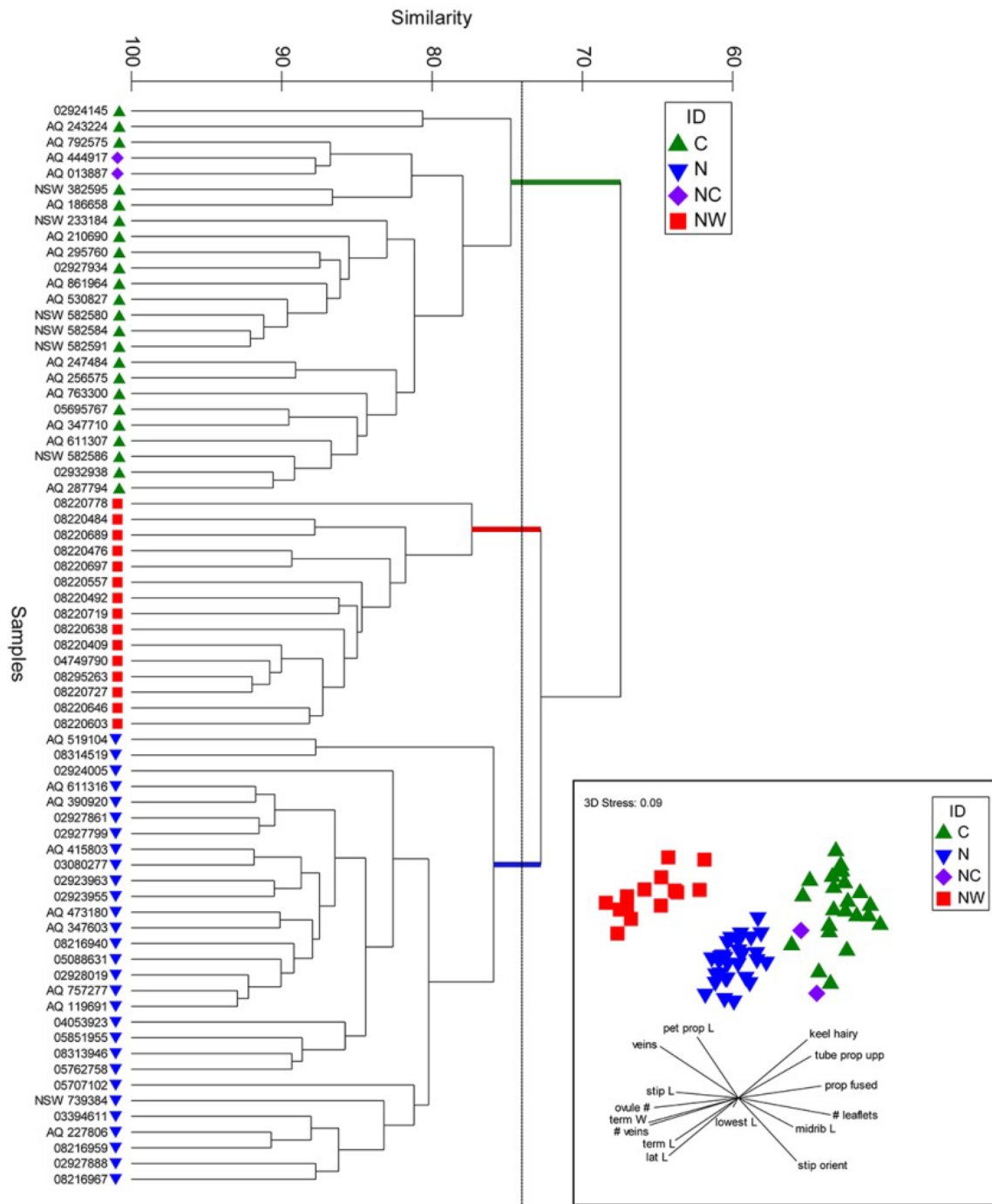


flower characters were exceptions to this and frequently comprised a single measure per sample due to the paucity of flowers on many specimens. Flowers were rehydrated and dissected to score calyx characters and ovule number. Because the specimens selected for analysis were required to have at least one mature flower on them, fully-developed fruit were not present on 19 specimens, with 44 specimens lacking mature seed. The three seed characters (length, width, length: width ratio) were therefore excluded from analysis and two separate datasets consisting of 1) all specimens (69) with fruit characters excluded and 2) all fruiting specimens (50) with fruit characters included, were analysed, to investigate the influence of fruit characters for defining groups. Correlations among quantitative characters were calculated prior to analysis and four characters with correlation coefficients >0.8 (upper calyx lip length, central lower calyx lobe length, lowest leaflet width, lowest leaflet length: width ratio) were also pruned from the datasets.

The morphometric datasets were analysed phenetically using Primer 6.1.13 (Clarke & Gorley 2006). Similarity matrices were generated using the Gower Metric (Gower 1971), which is suitable for use with datasets containing a mixture of qualitative and quantitative variables (Gower 1971; Crisp & Weston 1993). The space-conserving unweighted pair-group method of arithmetic averages (UPGMA) was employed to hierarchically cluster individuals into groups. Ordinations were derived from the Gower association matrix by using non-metric multidimensional scaling (NMDS). Ordinations were run 100 times from random starting configurations and the result with the lowest stress value (Kruskal stress formula 1 in Primer) in both two-dimensional and three-dimensional ordination space retrieved.

Both the ordination and classification (Figure 2) showed three groupings corresponding to these putative taxa, with two specimens viewed as being intermediate between *T. sp. Central* and *T. sp. Northern (N/C)* grouping with *T. sp. Central*. Spotting features for the taxa, based on the material available, are presented below (Table 4) to assist in their identification.

Since these analyses were performed, many more specimens have been seen on loan and during visits to other herbaria and the division of this complex into three taxa is now viewed as simplistic. *Tephrosia sp. NW Eremaean* is still a readily recognisable and cohesive taxon, but there are clearly more complex taxonomic patterns between and within the others, which are more widespread and occupy a greater diversity of habitats. While the voucher specimens upon which the phrase names are based are distinctly different and numerous other specimens clearly match these, it is viewed as possible that not all the specimens under those names belong there, including some used in the initial analyses. With study of more material, more-similar specimens to these have been seen, and had these been included in analyses additional groups may have been retrieved. This is particularly true of *T. sp. Central s. lat.* from which additional taxa may be recognised with ongoing study. It is also possible that each is a more polymorphic taxon than realised, but given the consistency of form of two sandplain taxa occurring across central Australia (i.e. *T. sphaerospora* F.Muell. and *T. sp. deserts*), and the vast tracts of under-collected country, the first scenario seems more probable.



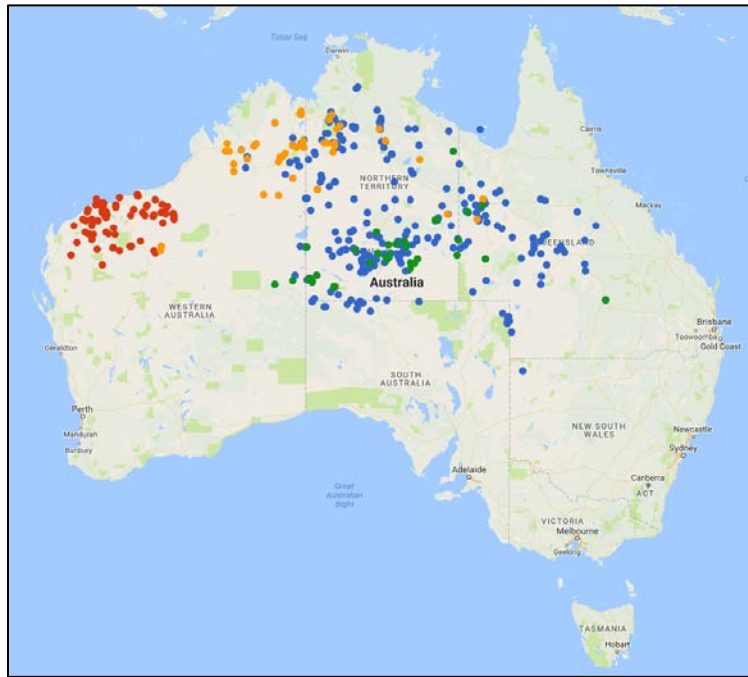
**Figure 2.** UPGMA dendrogram and three-dimensional NMDS ordination from the analysis of 69 samples of orange-flowered *Tephrosia supina* segregate specimens by 21 characters. Dotted line in the dendrogram indicates 74% similarity, at which three discrete groups can be identified. The direction of contribution to the ordination of each character having a Spearman rank correlation coefficient  $>0.75$ , is illustrated below. Sample labels not preceded by AQ or NSW are PERTH sheets. C = Central; N = Northern; NC = Northern/Central intermediate; NW = NW Eremaean. Character codes as for Appendix 1.

**Table 4.** Spotting features for the differentiation of *Tephrosia* sp. NW Eremaean, *T. sp.* Central and *T. sp.* Northern.

| <b><i>T. sp.</i> NW Eremaean (S. van Leeuwen et al. PBS 0356)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• restricted to the Pilbara and surrounds; most common concept of '<i>T. supina</i>' among botanists for the mining industry</li><li>• prostrate to erect habit</li><li>• most commonly 5–7 usually obovate leaflets (L:W ratio 1.3–2.8:1), with prominently brochidodromous venation and usually prominent reticulating intersecondary venation (best seen on the lower leaflet surface), the upper surface patently hairy or glabrous</li><li>• pale orange flowers, usually lacking hairs on the apex of the keel petals</li><li>• the calyx lobes very long relative to the calyx tube, the indumentum white</li><li>• 8–12(13) ovules</li><li>• pods straight, turgid, with a straight beak and patent indumentum</li></ul>                                                                                  |
| <b><i>T. sp.</i> Central (P.K. Latz 17037)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <ul style="list-style-type: none"><li>• occurs from around Telfer eastward and widespread across central Australia (NT, Qld, SA and NSW)</li><li>• straggly to erect habit</li><li>• most commonly 7–15 usually oblong or narrowly obovate leaflets (L:W ratio 1.7–5.6:1, highest in this group), with <math>\pm</math>craspedodromous venation and intersecondary veins scarcely visible, both leaflet surfaces with inclined, soft(ish) white hairs</li><li>• smaller, orange flowers, usually with hairs on the apex of the keel petals</li><li>• the calyx lobes c. the same length as the tube or shorter, the indumentum often golden to brownish, or white</li><li>• (5–)6–8 ovules</li><li>• pods gently curved, turgid (apparently narrower than the other taxa), with a straight to prominently deflexed beak and patent indumentum</li></ul> |
| <b><i>T. sp.</i> Northern (K.F. Kenneally 11950)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"><li>• mostly in the Kimberley and across the NT into Qld, but with outliers near Jigalong; shares different characters with each of the others</li><li>• spreading to low habit</li><li>• most commonly 7–11 usually obovate but sometimes narrowly obovate leaflets (L:W ratio 1.1–3:1), with <math>\pm</math>craspedodromous venation and lacking prominent intersecondary veins, both leaflet surfaces with inclined, soft(ish) white to gold hairs</li><li>• pale orange flowers, usually lacking hairs on the apex of the keel petals</li><li>• the calyx lobes very long relative to the calyx tube, the indumentum white</li><li>• 8–10(11) ovules</li><li>• <math>\pm</math>straight pods, turgid, sometimes upturned at apex with a straight beak and patent indumentum</li></ul>                            |

The geographic distributions of the three orange-flowered *T. supina* segregates indicates areas of overlap between all three taxa, with a few collections of *T. sp.* Northern occurring on the eastern edge of the range of *T. sp.* NW Eremaean (W edge of the Little Sandy Desert, E of Jigalong), and specimens of *T. sp.* Northern and *T. sp.* Central also intermixed around the NT/Qld border (Figure 3). Note that the majority of specimens

(blue) from central Australia and south-west Qld are still simply identified as ‘*T. supina*’ and that there are no obvious disjunctions. Additional study of the complex will clarify the distributions of *T. sp. Northern* and *T. sp. Central*.



**Figure 3.** Approximate distribution of the orange-flowered *T. supina* segregates in Australia, based on specimen data in the *Australasian Virtual Herbarium* (visualised here through the spatial portal tool of the *Atlas of Living Australia*). Red dots = specimens IDed as *T. sp. NW Eremaean*; yellow dots = specimens IDed as *T. sp. Northern*; green dots = specimens IDed as *T. sp. Central*; blue dots = specimens IDed as ‘*T. supina*’. Data was filtered to exclude all PERTH *T. supina* (*s. str.*) records and all specimens IDed as *T. supina* (*s. str.*) by R. Butcher, leaving those records to which the name *T. supina* has been misapplied, or mis-identified (NB: scattered collections in SE Qld and central Australia).

The spotting features provided above will allow specimens from this complex to be identified to one of these three taxa; however, the descriptions that follow for *T. sp. Central* and *T. sp. Northern* are based on a smaller sub-set of specimens, namely the voucher specimen and those matching them exactly.

### *Tephrosia clementii*

Industry interest in the Pilbara region, and therefore in the taxonomic resolution of difficult species and complexes, has driven revisionary work in *T. clementii* Skan, leading to the segregation of the following taxa from a complex surrounding *T. clementii* and *T. sphaerospora*—*T. sp. clay soils*, *T. sp. Newman*, *T. sp. North West Cape* and *T. sp. deserts*. They are described in the following report and revised descriptions of *T. clementii* and *T. sphaerospora* are provided.

The variation in this species has been recognised for some time and many botanists with extensive field experience in the Pilbara region (see, for e.g. Trudgen & Casson 1998; Trudgen & Assoc. 2002) have identified forms they felt worthy of recognition. Of interest, this project has now allowed some of those forms to be placed. Two of M.E. Trudgen's tag-named taxa, '*Tephrosia* aff. *clementii* (1) (MET 15,527)' and '*Tephrosia* aff. *clementii* (5)B184', perpetuated in the grey literature, could be attributed to *T. clementii* s. str. once type material had been viewed; for most people this name had been used for specimens now known as *T. sp. clay soils*. An additional Trudgen tag name, '*Tephrosia* aff. *clementii* (2)', can now be attributed to *T. sp. Newman*, while yet another, '*T. aff. clementii* (4) (M35-14)', from near Conzinc Bay in Murujuga [Burrup Peninsula] is still unplaced within the complex. The two specimens with this tag name are closest to *T. clementii* s. str. in overall morphology, but are distinctive in being covered with long, soft, white hairs. Revision of this complex is ongoing.

This group of orange-flowered taxa are prostrate to low-growing and have palmate, sub-pinnate, or pinnate leaves with 5–9 leaflets at maturity. Each taxon can be recognised by combinations of characters and some can be difficult to distinguish in the absence of critical features, especially fruits and seeds (Table 5). Key distinguishing features within this complex are: pattern of leaf division; leaflet shape and L:W ratio; indumentum distribution, density and orientation on leaflet surfaces; relative lengths of the calyx tube and lobes; flower size; pod shape and indumentum orientation; position and orientation of the pod beak; seed size, shape, and testa coloration and texture.

There is some variation within each species, which makes it difficult to isolate truly discriminating characters (e.g. palmate-leaved taxa may have a few subpinnate leaves on a specimen), and suites of morphological features are shared across different species (e.g. *T. clementii* and *T. sp. clay soils* have palmate leaves and small flowers; *T. sp. clay soils* and *T. sp. Newman* have seeds with a distinctly rugose testa; *T. sp. Newman*, *T. sphaerospora* and *T. sp. deserts* have pinnate leaves; *T. sp. deserts* and *T. clementii* have small, obovate seeds etc.). Care must be taken therefore to consider all parts of the plant when identifying taxa in this complex.

### ***Tephrosia rosea***

As a broadly defined species, *T. rosea* s. lat. is relatively easy to identify, its members having a shrub habit, pink–purple flowers with the calyx lobes and tube approximately the same length, leaves with a short petiole and commonly 5–7(–9) oblong-elliptic-obovate leaflets with noticeably parallel intersecondary venation, laterally compressed fruits that are curved upwards at the apex, and transversely obloid seeds with a mottled seed coat. There are two published varieties, *T. rosea* Benth. var. *rosea* and var. *clementii* Domin, both of which occur in the Pilbara along with two undescribed varieties, var. Fortescue Creeks and var. Port Hedland. These were previously known as var. *glabrior* Pedley ms and var. *venulosa* Pedley ms, but were given infraspecific phrase names under the APC project which sought, among other things, to ensure that it was clear whether taxa had been formally described. Many manuscript names (ms) across the flora had been



in use for decades without the species being validly described, many of them making their way into common use, including horticulture. A fifth phrase-named variety, var. Napier Range, occurs in the Kimberley region.

As well as these five formally and informally named varieties there is a range of more or less distinctive forms that could be recognised as new taxa, as well a large number of collections that sit somewhere intermediate between recognisable forms. In addition, *T. sp.* Kennedy Range (Carnarvon region) and *T. sp.* Mistake Creek (Kimberley) are also part of the *T. rosea* complex, as are *T. sp.* Adels Grove and *T. sp.* Glenormiston, widespread allies with phrase names established at the Queensland Herbarium. The protocol of using phrase names for putative new taxa in order to define them and communicate (and legislate) about them is relatively modern (Barker 2005); it is Pedley's habit to use manuscript names, hence a remarkable duplication of names in use at BRI. For example, *T. sp.* Adels Grove is also known there as *T. 'argyrea'* while *T. sp.* Glenormiston is known as *T. 'deserti'* (and also possibly as *T. 'boylandii'*). Other tag-names (for sorting) and manuscript names are in use at BRI for forms and taxa in the *T. rosea* complex (Table 1).

Both *T. sp.* Adels Grove and *T. sp.* Glenormiston appear to occur in WA; the first may be applicable to thickly and intensely silver-indumented specimens from the Kimberley at PERTH under the tag name *T. rosea* var. 'Halls Creek', and the second applicable to a single collection made from the Kiwirrkurra Indigenous Protected Area (IPA) in late 2015. Neither name has been added to the WA plant census at this stage as research is ongoing and, in both cases, the voucher specimen for each of those phrase names has not been seen. The possible informal synonymy of *T. rosea* var. 'Halls Creek' and *T. sp.* Adels Grove was identified during a visit to the Queensland Herbarium in 2012; however, there is variation among the var. 'Halls Creek' specimens and they may not all belong to the one taxon. It is uncertain at this stage which of them matches the *T. sp.* Adels Grove voucher. Similarly, there is variation among the loaned specimens of *T. sp.* Glenormiston, *T. 'deserti'* and *T. 'boylandii'* and, in the absence of the voucher, R.W. Purdie 1362, it is difficult to determine which form the Kiwirrkurra specimen best matches. A confounding factor is that BRI does not deliver records for specimens collected outside Queensland to AVH, so the distribution of both these phrase-named taxa in the NT is unknown. Records of *T. sp.* Glenormiston stop exactly on the border, and because this name is not on the NT flora census it is not knowable what name specimens matching this have been assigned to, or if it has been collected there at all.

As can be seen from the discussion above, resolution of the *T. rosea* complex requires an Australia-wide study. In summary, it presently comprises *T. rosea s. lat.* (specimens identified as *T. rosea* but not placed in a variety), *T. rosea* var. *rosea*, var. *clementii*, var. Fortescue Creeks, var. Port Hedland, var. Napier Range, var. 'short cuneate leaflets', var. 'Kimberley sericeous', var. 'Halls Creek', *T. sp.* Kennedy Range, *T. sp.* Mistake Creek, *T. sp.* Adels Grove/*T. 'argyrea'*, *T. sp.* Glenormiston/*T. 'deserti'*/*T. 'boylandii'*, and other forms... The complex is widespread across northern and central Australia, with the

**Table 5.** Spotting features for the taxa in the *Tephrosia clementii*–*T. sphaerospora* complex.

|                                         | <i>T. clementii</i>                  | <i>T. sp. clay soils</i>                       | <i>T. sp. Newman</i>                                     | <i>T. sp. North West Cape</i>                    | <i>T. sp. deserts</i>                      | <i>T. sphaerospora</i>              |
|-----------------------------------------|--------------------------------------|------------------------------------------------|----------------------------------------------------------|--------------------------------------------------|--------------------------------------------|-------------------------------------|
| <b>Leaf division</b>                    | palmate (±)                          | palmate (±)                                    | pinnate                                                  | palmate and sub-pinnate, occasionally pinnate    | pinnate, young leaves palmate              | pinnate                             |
| <b>Ultrajugal rachis</b>                | absent                               | absent                                         | rarely present (<6 mm)                                   | absent                                           | absent                                     | present, distinct                   |
| <b>Leaflet #</b>                        | (3–)5–7                              | (3–)5–9                                        | (3–)5–7                                                  | 5–7(–9)                                          | 3–5                                        | (3–)5–7(–9)                         |
| <b>Leaflet shape</b>                    | narrowly elliptic, elliptic, obovate | narrowly obovate to obovate                    | narrowly to broadly elliptic                             | narrowly obcuneate, narrowly obovate             | narrowly elliptic, elliptic, oblong        | narrowly elliptic                   |
| <b>Apex shape</b>                       | obtuse to rounded                    | obtuse to rounded                              | acute to obtuse                                          | truncate to retuse                               | obtuse to rounded                          | acute to obtuse                     |
| <b>Leaflet upper surface indumentum</b> | glabrous or puberulous, glabrescent  | glabrous or puberulous, glabrescent            | glabrous                                                 | loosely appressed                                | glabrous                                   | fine, appressed to patent           |
| <b>Leaflet lower surface indumentum</b> | dense, appressed                     | sparse to moderately dense, appressed          | moderately dense to dense, loosely appressed to inclined | moderately dense to dense, loosely appressed     | sparse to moderately dense, fine appressed | moderately dense, fine, appressed   |
| <b>Flowers at node</b>                  | 3                                    | c. 5                                           | 3–5                                                      | 2                                                | 1–3(–4)                                    | 3–6                                 |
| <b>Calyx length (mm)</b>                | 4.2–5.5                              | 3.3–5.1                                        | 5.7–7.5                                                  | 5.5–7                                            | 4.4–5.9                                    | 3–4.5                               |
| <b>Calyx lobes vs tube</b>              | long, slender, tube attenuate        | approximately equal                            | distinctly longer                                        | longer by c. 1/3                                 | long, slender; tube attenuate              | approximately equal to longer       |
| <b>Keel hairs</b>                       | absent                               | absent                                         | few                                                      | few                                              | few                                        | few                                 |
| <b>Fruit curvature</b>                  | straight                             | upturned at apex                               | ±straight or slightly upturned at apex                   | straight                                         | straight                                   | upturned at apex                    |
| <b>Fruit T.S.</b>                       | turgid                               | laterally compressed                           | turgid                                                   | raised over seeds to turgid                      | turgid                                     | raised over seeds, indented between |
| <b>Fruit indumentum</b>                 | patent                               | appressed                                      | patent (rarely loosely appressed)                        | inclined to patent                               | patent                                     | patent                              |
| <b>Seed shape</b>                       | ±orbicular to obovate                | transversely ellipsoid to oblong, reniform     | spherical, quadrate-pulvinate                            | obliquely ellipsoid                              | obovoid to broadly obovoid                 | ±orbicular to obovate               |
| <b>Testa texture</b>                    | smooth to broadly dimpled            | rugose                                         | rugose                                                   | smooth                                           | smooth to broadly dimpled                  | smooth                              |
| <b>Testa colour</b>                     | light brown, black-flecked           | orange-brown to brown, black-flecked, all dark | orange- to red-brown + brown, black-flecked              | orange-brown + brown, black-flecked and streaked | orange-brown, black-flecked                | boldly mottled                      |

greatest diversity apparently in WA, where some variation appears correlated to different substrates, soils and moisture gradients within regions, but considerable intergradation occurs between some forms. *Tephrosia rosea s. lat.* is represented by c. 400 specimens at PERTH alone (25% of which are IDed only to species; Table 6); 36% of the 845 records of *T. rosea* (incl. infrataxa) in AVH have only been identified to species level. A combined morphometric and molecular approach is needed to resolve taxonomic boundary issues at the species and infraspecific levels.

**Table 6.** Breakdown of the *Tephrosia rosea* collection at PERTH by numbers of specimens per taxon.

| ID                                    | Specimens | Notes                                                                                                                                                                                                                |
|---------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>T. rosea</i>                       | 400       | All specimens at PERTH, including the varieties below                                                                                                                                                                |
| <i>T. rosea</i> var. <i>rosea</i>     | 52        | Low number related to northern distribution + reluctance to ID to the autonym prior to lectotypification                                                                                                             |
| <i>T. rosea</i> var. <i>clementii</i> | 119       | Lumping ground for everything with appressed silvery leaves; multiple forms in here including appressed gold-green indumentum                                                                                        |
| <i>T. rosea</i> var. Fortescue Creeks | 82        | Good taxon, easy to ID. High number reflects collection across the Pilbara associated with mining + image vouchers (frequently photographed)                                                                         |
| <i>T. rosea</i> var. Port Hedland     | 40        | Very restricted distribution, specimens showing intergradation into var. <i>clementii</i> are also in here. High number represents continual sampling (P1 Flora) during development assessments and targeted surveys |
| <i>T. rosea</i> var. Napier Range     | 8         | Good taxon, easy to ID. Low number probably represents limited access to its populations                                                                                                                             |
| <i>T. rosea</i> 'indet'               | 99        | c. ¼ of all samples only IDed to species level; multiple forms in here including probable new taxa. Also specimens probably attributable to named varieties, especially var. <i>rosea</i>                            |

In this report a diagnostic description is provided for *T. rosea s. lat.* and the three phrase-named varieties on the WA plant census (var. Fortescue Creeks, var. Napier Range, var. Port Hedland) with expanded descriptions provided for *T. sp.* Kennedy Range and *T. sp.* Mistake Creek. This has been done primarily for consistency with other phrase-named taxa. Issues of taxonomic rank within the *T. rosea* complex still need to be investigated.

### ***Conservation taxa and continuous assessments***

None of the *Tephrosia* taxa in WA are gazetted as Rare Flora (Threatened Flora) under the *Wildlife Conservation Act 1950*, but nine taxa are presently considered conservation Priority Flora (Smith 2017). At the project's commencement there were five Priority Flora listed, with three of these having no change in status since 2011 (Table 7). Of the remaining two, *T. bidwillii* was removed from the census after taxonomic review found that it didn't occur in WA and that the name had been misapplied to specimens of *T. sp.* B Kimberley Flora, *T. sp.* D Kimberley Flora and *T. sp.* Fortescue. This was a good conservation outcome for WA. *Tephrosia sp.* Cathedral Gorge (F.H. Mollemans 2420)

was placed on the census in 1995 with a conservation listing of Priority One, but this was downgraded to Priority Three in 1999. In 2003 the name *T. sp. Pilbara Ranges* (S. van Leeuwen 4246) was added to the census and the taxon was conservation listed at Priority Three in 2008. Taxonomic review by P.J.H. Hurter in 2009 determined that *T. sp. Cathedral Gorge* and *T. sp. Pilbara Ranges* were the same taxon and they were synonymised under the former name in 2010; their combined numbers and distribution warranted the removal of the taxon from the *Declared Rare and Priority Flora List for Western Australia* in the same year (Smith 2010).

Desktop conservation assessments were performed for taxa as part of the process of erecting a new name on the census. Recommendations to the Department's Species and Communities branch are based on all available information, in particular, number of populations, their geographic extent, frequency of plants within populations, whether the populations occur within conservation reserves, and whether they are under immediate or foreseeable threat. Recommendations to add or remove names to the Priority list, or to change the Priority status of a taxon, can be made at any time, with *FloraBase* displaying the current conservation listing.

**Table 7.** Summary of conservation-listed *Tephrosia* in WA (as of May 2017), including changes in status resulting from this project and reasons for change.

| Taxon                             | DPaW conservation code | Change | Reason                                                                                             |
|-----------------------------------|------------------------|--------|----------------------------------------------------------------------------------------------------|
| <b>Current</b>                    |                        |        |                                                                                                    |
| <i>T. andrewii</i>                | P1                     | N      | -                                                                                                  |
| <i>T. rosea</i> var. Napier Range | P3                     | Y      | New taxon; poorly known                                                                            |
| <i>T. rosea</i> var. Port Hedland | P1                     | N      | -                                                                                                  |
| <i>T. sp. Kennedy Range</i>       | P1                     | Y      | New taxon; poorly known, restricted                                                                |
| <i>T. sp. Kununurra</i>           | P2                     | Y      | New taxon; poorly known                                                                            |
| <i>T. sp. Mistake Creek</i>       | P3                     | Y      | New taxon; poorly known                                                                            |
| <i>T. sp. North West Cape</i>     | P2                     | Y      | New taxon; poorly known                                                                            |
| <i>T. sp. Saw Ranges</i>          | P1                     | Y      | New taxon; poorly known, restricted                                                                |
| <i>T. valleculata</i>             | P3                     | N      | -                                                                                                  |
| <b>Non-current</b>                |                        |        |                                                                                                    |
| <i>T. bidwillii</i>               | P3                     | Y      | Excluded taxon; not in WA                                                                          |
| <i>T. sp. Cathedral Gorge</i>     | P1 (1995)<br>P3 (1999) | Y      | Removed from list; synonymised with <i>T. sp. Pilbara Ranges</i> ; described as <i>T. oxalidea</i> |

### ***Identification tools***

Taxa can be identified using a range of tools including written and electronic keys, detailed morphological descriptions, photographs and drawings, comparison of specimens against other specimens, and through fact sheets or lists of spotting features that summarise key diagnostic characters. This report uses a combination of descriptions, images, spotting features and discussions of affinities, in which morphologies between

similar or closely related taxa are compared, to facilitate the accurate identification of the phrase-named taxa in WA.

At the project's commencement there were composite images available on *FloraBase* for 13 *Tephrosia* taxa; there are only 9 images available now. This is a direct result of increased taxonomic expertise in the genus, leading to names being removed from the census (e.g. *T. bidwillii*; excluded, images were of *T. sp.* Fortescue) or recognition that the displayed image was incorrect for the taxon. Ensuring quick removal of erroneous images prevents continued misidentification of taxa by people using photographs as identification aids. The Western Australian Herbarium no longer compiles and publishes composite images of taxa through *FloraBase*, because of issues surrounding poor resolution, choice of representative images, dictates of composition and framing, and difficulties associated with replacing a single image within a composite. Over the course of this project, 165 *Tephrosia* images representing 20 taxa (17 not previously included; 12 of these undescribed) were submitted to the new *ImageBank* system to allow taxa, especially those in the Pilbara and Gascoyne region (Table 8), to be better identified. Images of an additional 10 *Tephrosia* taxa are now available to upload.

The new *ImageBank* system allows a central repository of curated and annotated images to be searched and downloaded; tagging of images (e.g. diagnostic, or fruit, or flower, or a combination of tags etc.) increases their information value and allows users to retrieve images that best match their needs. It is also possible for users to easily view links between images and voucher specimens, and to see what permissions are associated with images. *ImageBank v. 2* has just been released, but is still not available to the public or accessible through *FloraBase*. This is timelined for December 2017.

The reference herbarium at PERTH is an invaluable resource for the identification of plant specimens and is regularly used by botanical consultants in the preparation of flora survey reports for the mining industry. Through continuous review of taxon representation and specimen quality there are now 72 specimens, representing 56 different *Tephrosia* taxa, in the reference herbarium collection. Some taxa have multiple specimens to show variation within the species or to make the collection complete and informative (i.e. flowering + fruiting material). Material for 21 taxa not previously represented was added during this project, including for 14 taxa added to the census as a result of research. The only taxa not presently represented in the reference herbarium are *T. conspicua* W.Fitzg., *T. laxa* var. *angustata* Domin, *T. spechtii* Pedley, *T. sphaerospora* s. str., *T. sp.* G Kimberley Flora and *T. sp.* Yampi.

Herbarium-based specimen curation and data management has included the identification and annotation of 640 PERTH *Tephrosia* specimens, plus hundreds of specimens at the herbaria that have been visited. Well-curated collections are needed to ensure that herbarium data delivered to AVH and the *Atlas of Living Australia* (ALA) is as accurate as possible. With over 8 billion occurrence records downloaded through ALA to date and used in a vast array of downstream projects, the importance of up to date taxonomies, stable and comparable nomenclatures, and accurately identified specimens cannot be overstated.

**Table 8.** *Tephrosia* taxa of the Pilbara and Gascoyne regions, indicating those for which images are currently available in *FloraBase* and contributions to *ImageBank* during this project.

| <b>Taxon</b>                          | <b>FloraBase</b> | <b>ImageBank</b> |
|---------------------------------------|------------------|------------------|
| <i>T. arenicola</i>                   | -                | Y                |
| <i>T. clementii</i>                   | -                | Y                |
| <i>T. leptoclada</i>                  | Y                | Y                |
| <i>T. oxalidea</i>                    | -                | Y                |
| <i>T. remotiflora</i>                 | Y                | -                |
| <i>T. rosea</i> var. <i>clementii</i> | Y                | Y                |
| <i>T. rosea</i> var. Fortescue Creeks | -                | Y                |
| <i>T. rosea</i> var. Port Hedland     | -                | Y                |
| <i>T. rosea</i> var. <i>rosea</i>     | Y                | -                |
| <i>T. simplicifolia</i>               | -                | Y                |
| <i>T. stipuligera</i>                 | -                | Y (not RB)       |
| <i>T. supina</i>                      | -                | Y                |
| <i>T. uniovulata</i>                  | Y                | Y                |
| <i>T. virens</i>                      | -                | Y                |
| <i>T. sp. B Kimberley Flora</i>       | Y                | Y                |
| <i>T. sp. Bungaroo Creek</i>          | Y                | Y                |
| <i>T. sp. Carnarvon (+Onslow)</i>     | -                | Y                |
| <i>T. sp. clay soils</i>              | -                | Y                |
| <i>T. sp. D Kimberley Flora</i>       | -                | Y                |
| <i>T. sp. deserts</i>                 | -                | Y                |
| <i>T. sp. Dunes</i>                   | -                | Y                |
| <i>T. sp. Fortescue (+Meentheena)</i> | -                | Y                |
| <i>T. sp. Magazine Hill</i>           | -                | -                |
| <i>T. sp. Newman</i>                  | -                | Y                |
| <i>T. sp. Northern</i>                | -                | Y                |
| <i>T. sp. NW Eremaean</i>             | -                | Y                |
| <i>T. sp. Willowra</i>                | -                | -                |

To facilitate the correct identification of *Tephrosia* specimens collected in WA, diagnostic descriptions are provided for three re-circumscribed taxa and 29 phrase-named taxa, 18 of which were recognised as new during the course of this project (17 are current, with *T. sp. Onslow* being considered conspecific with *T. sp. Carnarvon* in this report). In the absence of a comprehensive key to the species and infraspecies of *Tephrosia*, at this point in time, comparative iconography is employed herein. Images (where available) show the features that may clarify the descriptions for those unfamiliar with taxonomic terms.

### *Status update*

This project has, for the first time, clarified the taxonomy of *Tephrosia* in WA to the point that newly collected specimens can be identified, be that to a named or unnamed taxon or a definable complex that requires further work. The taxonomic framework that is now in place through having a well-curated specimen collection at PERTH is proving invaluable to researchers, conservation staff and industry personnel. This is evident in the substantially decreased number of mis-identified specimens being submitted to PERTH by those that have accessed either the reference or research collection. The taxonomic expertise in *Tephrosia* that has been fostered at the Western Australian Herbarium, through the opportunities provided by this project, cannot be underestimated.

Despite the significant advances in our knowledge of *Tephrosia* in northern WA, there is still considerable work to do. In order to fully-resolve the taxonomic issues in this genus, including outstanding problems in the Pilbara and Gascoyne regions, there is a need to tackle *Tephrosia* Australia-wide, rather than taking a regional approach. This has been highlighted by the ongoing discovery of highly disjunct populations of taxa. For example, at the completion of the *T. supina* study, the most similar taxa to *T. supina* s. str. (*T. sp.* Willowra, *T. sp.* Magazine Hill) were found in the NT and Qld; both are now also known from one or two confirmed collections in WA, two of which are in the Pilbara (*T. sp.* Willowra: 40 km E Newman; *T. sp.* Magazine Hill: Hamersley Range), within the geographic range of *T. supina*. The nearest conspecific collections to each of these are at least 600 km away. Similar disjunctions are seen in *T. sp.* Northern (Figure 3) with two collections from the edge of the Pilbara/Gascoyne region and the next collections on the edge of the Tanami; also possibly *T. remotiflora*, to which a small number of still unplaced specimens from the Peedamulla area are clearly closely allied. Understanding patterns of variation in *T. rosea* s. lat. also requires Australia-wide research.

In summary, the following issues still exist:

- a number of complexes, many of which are waiting on lectotypification of key species and input from external researchers
- identification difficulties related to convergent vegetative morphologies between disparate taxa, making them impossible to identify from sterile material
- putatively new taxa known from too few collections to properly assess variation and status relative to most-similar taxa
- widespread and variable taxa with geographic ranges covering poorly collected and difficult to access areas
- disjunct taxa with morphological differences that need to be assessed qualitatively
- infraspecific variation that makes producing definitive identification guides difficult

- incomplete collections (i.e. missing fruits or flowers)
- taxa distributed across different geopolitical areas, and subject to different classifications and nomenclatures
- siloed research and existing taxonomic proprietaries that need to be reconciled
- on-going new discoveries (e.g. *T. sp.* North West Cape added to the census in 2016; *T. sp.* Glenormiston collected for the first time in 2015)
- new nomenclatural information (e.g. that *T. sp.* O.T. Station should be a synonym of *T. sp.* Magazine Hill, not the other way around as previously thought).

### ***Future directions***

The next phase of revisionary studies in *Tephrosia* involves close collaboration with Cowie to formally describe all the phrase-named taxa occurring in WA and the NT; a task that is well-underway, with descriptions having been prepared for all WA taxa. These concepts will need to be solidified and expanded with the study of additional material, and to be published in collaboration with Cowie, where they are taxa in which he has an IP stake.

To this end additional funding has been sought from the Australian Biological Resources Study (ABRS) through their National Taxonomy Research Grant Programme (NTRGP). Following highly regarded but ultimately unsuccessful applications for the 2015 and 2016 grant rounds—in which it was proposed to produce a comprehensive molecular phylogeny and taxonomic revision of *Tephrosia* Australia-wide—a modified application for the 2017 round was successful. This will provide funding from 2017–2020 to:

- 1) prepare an electronic Flora treatment for all the taxa in WA and the NT for the *eFlora of Australia*;
- 2) resolve the *T. rosea* complex through combined morphological and molecular analyses;
- 3) formally describe all the unnamed taxa (c. 40 taxa) in WA and the NT;
- 4) produce a taxonomic key for *Tephrosia* Australia-wide.

This project will enable knowledge about this important group of legumes to be transferred from senior researchers Cowie and Pedley to earlier-career researcher Butcher and ensure that there is on-going expertise in this large and difficult group. A value-add to this project will be collaboration with an international research group, through the contribution of samples for DNA analysis from all the Australian *Tephrosia* taxa, for the production of a framework phylogeny for the genus. Comparative studies into morphological and molecular diversification in *Tephrosia* in two major centres of



taxonomic diversity – Australia and Africa – will run in parallel with revisionary work in both continents.

This framework phylogeny will allow us to better understand the patterns of movement of the genus into the Australian monsoon tropics (AMT) and its subsequent diversification in the AMT and the Eremaean. The dominance of *Tephrosia* in the AMT makes the genus a particularly important one for interpreting biogeographic patterns, yet it is poorly resolved there; 75% of the phrase-named taxa in Australia occur in the AMT. Like the Pilbara region (cf. 16% informal taxa) the AMT is under increasing exploitation pressure. Novel forms and putatively new taxa are frequently collected when environmental impact surveys are undertaken, particularly in under-explored areas. These need to be taxonomically understood if conservation and sustainability goals are to be met in the face of projected extensive developments in the region.

Clearly, formal publication of the phrase-named taxa, as an output for the ABRS grant, builds on the expertise gained during this project as well as the substantial progress towards their resolution and description, as shown herein. These descriptions will be fine-tuned in collaboration with Cowie and Pedley, and in some cases expanded following the inclusion of data from specimens held at other institutions or from new information obtained from field observations and new collections. The significant financial support provided by Rio Tinto Iron Ore Pty Ltd through the Mesa A Offset, towards the resolution of *Tephrosia*, will be acknowledged in all publications in which taxa from WA are revised or described, as well as any phylogenetic studies.

## ***Summary of taxonomic and nomenclatural changes***

The outcomes of taxonomic research are varied, but central to all endeavours is the aim of defining things and making sure those things have only one name. This is vital to ensure effective communication about, and comparable study into things, their distributions and their ecologies. A taxonomic study can lead equally to a list of accepted names becoming longer (e.g. as more things are defined and given names), or shorter (e.g. when it is discovered that two names refer to a single thing and one name is removed), or staying the same length (e.g. if the wrong name for a thing is replaced with the correct name, or when the number of names added equals the number of names removed). Lists of names typically refer to particular areas and so can also increase and decrease in length when named things are determined to occur in that area or not. Similar investigative effort goes into the shortening of a list of names as to its expansion, although further effort is required to then produce the descriptions and tools by which others can unambiguously link a thing with its accepted name. In *Tephrosia* the list of names in use in WA (as per the vascular plant census) has undergone expansions, contractions and shifts sideways; these are summarised below.

Clarifying and managing the names in use for different *Tephrosia* taxa has been particularly challenging, because the genus occurs across central and northern Australia, is being revised by three different people based at different State herbaria, each of which uses a different database system and has different institutional policies on the use and release of data for informal names, because many taxonomic concepts differ between those three people, and lastly, because *Tephrosia* is taxonomically challenging and close to 50% of its (currently known) taxa aren't yet described. Nonetheless, concerted efforts towards collaboration, over siloed research, have meant that the majority of informal names used for taxa that occur in WA, at least, have now been reconciled between PERTH, DNA and BRI. This process has been greatly assisted by the APC project, which aims to produce a master list of accepted names, listing all known synonyms and instances of institutional differences in the uptake and application of names. The APC can only produce a consensus of the names on censuses, however. Names *in sched.* or voucher-linked names not on censuses are not included, and it is often these that are the most confusing.

It must be noted that even when an APC-approved name is available, individuals and institutions often continue to use their existing in-house names. This is unfortunate because it can hamstring the utility of national data aggregation and provision services such as AVH and the ALA. If a name is not included in the APC, then the ALA's name matching service will not be able to link them and deliver a comprehensive set of record data. In turn this affects the ability of on-ground environmental officers and consultants to prepare field survey strategies or desk-top conservation assessments. The significant improvements in our knowledge of informal name use in *Tephrosia* (Table 1; synonymies in Taxonomy section), made possible through this project, make it much easier to negotiate these issues.

**Excluded taxa:**

Two names were removed from the Western Australian vascular plant census.

- *T. bidwillii* Benth. (species occurs in Qld and NSW; not in WA)
- *T. clelandii* Pedley ms (taxonomic concept unknown and disparate; not applicable to any WA specimens)

**Reinstated taxa:**

Two names were reinstated on the census after prior removal; taxa now confirmed to be in WA.

- *T. filipes* Benth. [*T. filipes* var. *filipes*]
- *T. stuartii* Benth.

**Additions of named taxa:**

One named taxon was added to the census after being found to also occur in WA.

- *T. brachyodon* var. *longifolia* (Benth.) Domin

**Informal synonymy (within WA):**

Four phrase-named taxa were found to be the same as another phrase-named taxon.

- *T. sp.* Crowded pinnae (C.R. Dunlop 8202)  $\equiv$  *T. sp.* E Kimberley Flora (C.A. Gardner 9937) (two names in use in WA for the same taxon)
- *T. sp.* Pilbara Ranges (S. van Leeuwen 4246)  $\equiv$  *T. sp.* Cathedral Gorge (Mollemans 2420) (reconciled as being the same taxon through study; now described as *T. oxalidea*)
- *T. sp.* Meentheena (S. van Leeuwen 4479)  $\equiv$  *T. sp.* Fortescue (A.A. Mitchell 606) (reconciled as being the same taxon through study)
- *T. sp.* Onslow (K.R. Newbey 10571)  $\equiv$  *T. sp.* Carnarvon (J.H. Ross 2681) (reconciled as being the same taxon through study; infraspecific status may be warranted)

**Informal synonymy through APC name protocols (within WA; ms to PN):**

Four manuscript names were converted to phrase names under APC name protocols.

- *T. densa* (Benth.) Pedley ms > *T. sp.* Fortescue (A.A. Mitchell 606)
- *T. gardneri* Pedley ms > *T. sp.* Carnarvon (J.H. Ross 2681)
- *T. rosea* var. *glabrior* Pedley ms > var. Fortescue creeks (M.I.H. Brooker 2186)
- *T. rosea* var. *venulosa* Pedley ms > var. Port Hedland (A.S. George 1114)

### Informal synonymy between WA and other States/Territories:

Thirteen phrase-named and other informally recognised taxa were found to have different names at different institutions within Australia (see Table 1 for details, including additional ms and *in sched.* names). The currently accepted name (in APC) is given on the right.

- *T. phaeosperma* var. Westmoreland (S. Melville 967)  $\equiv$  *T. sp.* Pentecost River (I.D. Cowie 4168)
- *T. sp.* Barrow Creek (G.M. Chippendale 921)  $\equiv$  *T. sp.* D Kimberley Flora (R.D. Royce 1848)
- *T. sp.* Crowded pinnae (C.R. Dunlop 8202)  $\equiv$  *T. sp.* E Kimberley Flora (C.A. Gardner 9937)
- *T. sp.* Crows foot (I.D. Cowie 8562)  $\equiv$  *T. sp.* G Kimberley Flora (G.J. Keighery 4828)
- *T. sp.* Balcanoona Creek (K. Alcock AQ457802)  $\equiv$  *T. sp.* Granite (P.K. Latz 12116)
- *T. sp.* Finucane Island (R. Story 8206)  $\equiv$  *T. rosea* var. Port Hedland (A.S. George 1114)
- *T. sp.* Katherine (H.S. McKee 8509)  $\equiv$  *T. sp.* B Kimberley Flora (C.A. Gardner 7300)
- *T. sp.* Sinuate (T.G. Hartley 14337)  $\equiv$  *T. sp.* F Kimberley Flora (B.R. Maslin 5139)
- *T. sp.* O.T. Station (S.T. Blake 17659)  $\equiv$  *T. sp.* Magazine Hill (P. Jones 365)
- *T. sp.* Tanami Desert (P.K. Latz 11978)  $\equiv$  *T. sp.* Dunes (J.R. Maconochie 938)
- *T. 'quinquefolia'*  $\equiv$  *T. sp.* Willowra (G.M. Chippendale 4809)
- *T. rosea* 'short inflorescences'  $\equiv$  *T. sp.* Mistake Creek (A.C. Beauglehole 54424)
- *T. rosea* 'Halls Creek'  $\equiv$  *T. sp.* Adels Grove (A. de Lestang 359)

Two suggested informal synonyms, between names in use in WA and Qld, were investigated and synonymy was not found to be warranted; those names are retained.

- *T. sp.* C Kimberley Flora (K.F. Kenneally 5599) [PERTH]  $\neq$  *T. sp.* Mt Isa (P.L. Harris 277) [*p.p.*; a.k.a. *T. 'sparsifolia'* *in sched.*] [BRI]
- *T. sp.* D Kimberley Flora (R.D. Royce 1848) [ $\equiv$  *T. sp.* Barrow Creek (G.M. Chippendale 921)]  $\neq$  *T. benthamii* Pedley

### Re-circumscribed taxa:

Three species in WA have re-defined descriptions following revision.

- *T. clementii* Skan
- *T. sphaerospora* F.Muell.
- *T. supina* Domin

### **Species formally described during project:**

One species has been formally published to date.

- *T. oxalidea* R.Butcher & P.J.H.Hurter (was *T. sp.* Cathedral Gorge)

### **Phrase-named taxa still under investigation (names in use elsewhere):**

Two phrase names in use at BRI, included in the *T. rosea* complex, are applicable to WA material; however, their taxonomic status is still being investigated. These names are likely to be erected on the census.

- *T. sp.* Adels Grove (A. de Lestang 359)
- *T. sp.* Glenormiston (R.W. Purdie 1362)

### ***Tephrosia* taxa currently recognised in Western Australia**

Thirty-four named taxa are currently recognised in WA; study to date has determined that some of these (e.g. *T. remotiflora*, *T. crocea*, *T. oblongata*) probably contain more than one taxon; they will be investigated further.

- *T. andrewii* Cowie
- *T. arenicola* Maconochie
- *T. brachycarpa* Benth.
- *T. brachyodon* var. *longifolia* (Benth.) Domin
- *T. clementii* Skan
- *T. conspicua* W.Fitzg.
- *T. coriacea* Benth.
- *T. crocea* Benth.
- *T. filipes* Benth. var. *filipes*
- *T. flammea* Benth. var. *monophylla* W.Fitzg.
- *T. forrestiana* F.Muell.
- *T. lasiochlaena* Cowie
- *T. laxa* Domin var. *angustata* Domin
- *T. leptoclada* Benth.
- *T. macrocarpa* Benth.
- *T. oblongata* Benth.
- *T. oxalidea* R.Butcher & P.J.H.Hurter
- *T. phaeosperma* Benth.
- *T. polyzyga* Benth.
- *T. procera* Cowie
- *T. remotiflora* Benth.
- *T. rosea* Benth. *s. lat.*
- *T. rosea* var. *clementii* Domin
- *T. rosea* var. *rosea*
- *T. simplicifolia* Benth.

- *T. spechti* Pedley
- *T. sphaerospora* F.Muell.
- *T. stipuligera* W.Fitzg.
- *T. stuartii* Benth.
- *T. subpectinata* Domin
- *T. supina* Domin
- *T. uniovulata* F.Muell.
- *T. valleculata* Cowie
- *T. virens* Pedley

Twenty-nine phrase-named taxa are currently recognised in WA (18 of these recognised as new during this project\*, 17 currently accepted):

- *T. rosea* var. Fortescue creeks (M.I.H. Brooker 2186)
- *T. rosea* var. Napier Range (C.R. Dunlop 7760 & B.K. Simon)\*
- *T. rosea* var. Port Hedland (A.S. George 1114)
- *T. sp.* B Kimberley Flora (C.A. Gardner 7300)
- *T. sp.* Bungaroo Creek (M.E. Trudgen 11601)
- *T. sp.* C Kimberley Flora (K.F. Kenneally 5599)
- *T. sp.* Carnarvon (J.H. Ross 2681) [+*T. sp.* Onslow (K.R. Newbey 10571)\*]
- *T. sp.* Central (P.K. Latz 17037)\*
- *T. sp.* clay soils (S. van Leeuwen et al. PBS 0273)\*
- *T. sp.* D Kimberley Flora (R.D. Royce 1848)
- *T. sp.* deserts (J.R. Maconochie 1403)\*
- *T. sp.* Dunes (J.R. Maconochie 938)\*
- *T. sp.* E Kimberley Flora (C.A. Gardner 9937)
- *T. sp.* F Kimberley Flora (B.R. Maslin 5139)
- *T. sp.* Fortescue (A.A. Mitchell 606) [+*T. sp.* Meentheena (S. van Leeuwen 4479)]
- *T. sp.* G Kimberley Flora (G.J. Keighery 4828)
- *T. sp.* Kennedy Range (J.S. Beard 4392)\*
- *T. sp.* Kununurra (T.H. Handasyde TH00 250)\*
- *T. sp.* Magazine Hill (P. Jones 365)\*
- *T. sp.* Mistake Creek (A.C. Beaglehole 54424)\*
- *T. sp.* Newman (A.A. Mitchell PRP 29)\*
- *T. sp.* North West Cape (G. Marsh 81)\*
- *T. sp.* Northern (K.F. Kenneally 11950)\*
- *T. sp.* NW Eremaean (S. van Leeuwen et al. PBS 0356)\*
- *T. sp.* Pentecost River (I.D. Cowie 4168)
- *T. sp.* Saw Ranges (D. Kabay s.n. PERTH 06720544)\*
- *T. sp.* sparse pinnae (C.R. Michel 2202)\*
- *T. sp.* Willowra (G.M. Chippendale 4809)\*
- *T. sp.* Yampi (A.N. Start per R.L. Barrett RLB 2291)\*

**Table 9.** Summary of changes to the Western Australian vascular plant census resulting from this project. Year = year change recorded on the census. > and < indicate replacement names through *Australian Plant Census* (APC) protocols and taxonomic synonymy, including formal publication.

| Year        | Names added<br>(new taxa)         | Names added<br>(taxa reinstated)      | Names added<br>(taxa now in WA)             | Names added<br>(nomenclature changes)   | Names removed<br>(reason given)                                  |
|-------------|-----------------------------------|---------------------------------------|---------------------------------------------|-----------------------------------------|------------------------------------------------------------------|
| <b>2012</b> | <i>T. sp.</i> clay soils          | <i>T. filipes</i> var. <i>filipes</i> | <i>T. brachyodon</i> var. <i>longifolia</i> | <i>T. sp.</i> Fortescue >               | < <i>T. densa</i> ms [APC]                                       |
|             | <i>T. sp.</i> Dunes               | <i>T. stuartii</i>                    |                                             | <i>T. sp.</i> Carnarvon >               | < <i>T. gardneri</i> ms [APC]                                    |
|             | <i>T. sp.</i> Kennedy Range       |                                       |                                             | <i>T. rosea</i> var. Fortescue Creeks > | < <i>T. rosea</i> var. <i>glabrior</i> ms                        |
|             | <i>T. sp.</i> Kununurra           |                                       |                                             |                                         | <i>T. sp.</i> Crowded pinnae [≡ <i>T. sp.</i> E Kimberley Flora] |
|             | <i>T. sp.</i> Onslow              |                                       |                                             |                                         | <i>T. bidwillii</i> [excluded, not in WA]                        |
|             | <i>T. sp.</i> Pilbara             |                                       |                                             |                                         |                                                                  |
|             | <i>T. sp.</i> Saw Ranges          |                                       |                                             |                                         |                                                                  |
|             | <i>T. sp.</i> sparse pinnae       |                                       |                                             |                                         |                                                                  |
| <b>2013</b> | <i>T. rosea</i> var. Napier Range |                                       |                                             | <i>T. rosea</i> var. Port Hedland >     | < <i>T. rosea</i> var. <i>venulosa</i> ms [APC]                  |
|             | <i>T. sp.</i> Central             |                                       |                                             | <i>T. oxalidea</i> >                    | < <i>T. sp.</i> Cathedral Gorge [taxon published]                |
|             | <i>T. sp.</i> Mistake Creek       |                                       |                                             |                                         | <i>T. sp.</i> Pilbara [≡ <i>T. supina</i> s. str.]               |
|             | <i>T. sp.</i> Newman              |                                       |                                             |                                         | <i>T. clelandii</i> ms [excluded, not in WA]                     |
|             | <i>T. sp.</i> Northern            |                                       |                                             |                                         |                                                                  |
|             | <i>T. sp.</i> NW Eremaean         |                                       |                                             |                                         |                                                                  |
|             | <i>T. sp.</i> O.T. Station        |                                       |                                             |                                         |                                                                  |
| <b>2014</b> | <i>T. sp.</i> deserts             |                                       |                                             |                                         |                                                                  |
|             | <i>T. sp.</i> Yampi               |                                       |                                             |                                         |                                                                  |
| <b>2015</b> | <i>T. sp.</i> Willowra            |                                       |                                             |                                         |                                                                  |
| <b>2016</b> | <i>T. sp.</i> North West Cape     |                                       |                                             |                                         |                                                                  |
| <b>2017</b> |                                   |                                       |                                             | <i>T. sp.</i> Magazine Hill >           | < <i>T. sp.</i> O.T. Station [APC]                               |

## ***Taxonomy***

### ***Methods and explanatory notes***

The information provided in the following part of this report is based on examination of herbarium specimens of *Tephrosia* from the following collections: AD, BRI, CANB, DNA, K, MEL, NSW, NT and PERTH (see Glossary; herbarium codes from Thiers, contin. updated). Only the PERTH collection has been studied exhaustively, with herbarium visits and loaned specimens from other institutions concentrating on the Western Australian material within their collections.

These descriptions concentrate on the characters by which the taxa can be recognised and identified, and therefore may not be perfectly comparable across all features for all taxa treated. Many taxa have not been seen in the field and information on habitat, associated species, plant habit and dimensions, and flower colour have been taken from specimen labels. It is acknowledged that the collectors of these specimens may have made errors or misinterpretations, and that these may be unintentionally repeated herein.

Descriptive terminology follows Butcher and Hurter (2012), which is in turn based on Cowie (2004). Leaf venation terms follow Ellis *et al.* (2009) and appear in the Glossary. Certain terms in botanical taxonomic descriptions are subject to interpretation error through having been loosely defined in the past and hence used in conflicting ways. To ensure that taxa are able to be distinguished and identified correctly, some terms commonly used to describe indumentum (following Harris & Harris 1994) are defined in the Glossary.

### ***Lifeform and habit***

Species of *Tephrosia* are recognised to be annual or perennial (either short-lived or long-lived) and this can be difficult to determine with certainty in the field for smaller plants, many of which produce annual parts from a perennial rootstock, or underground storage organs in the case of some Kimberley taxa. Many taxa quickly put down a tap root and develop significant above-ground biomass, including thickened corky stems.

Differences in habit within some taxa can be pronounced, and attempts to subdivide variable taxa on combinations of habit and other morphological features frequently fall foul of intergrading specimens. For example, *T. sp.* Dunes (at its extremes) can be an erect, open shrub to 1.5 m tall, with linear leaflets and appressed indumentum or a prostrate to decumbent subshrub to 2 m wide, with broadly oblong leaflets and patent indumentum; *T. sp.* Carnarvon was regarded as only being a low,  $\pm$ spreading subshrub (possibly annual?) while *T. sp.* Onslow was differentiated by being an erect, woody shrub, but the other subtle characters by which they were distinguished were inconsistent and they are regarded as the same species herein. Variation in habit was also been observed in *T. sp.* Bungaroo Creek, which can be low and spreading to erect and openly branched. For many other taxa, however, habit is conservative.



### *Leaves and leaflets*

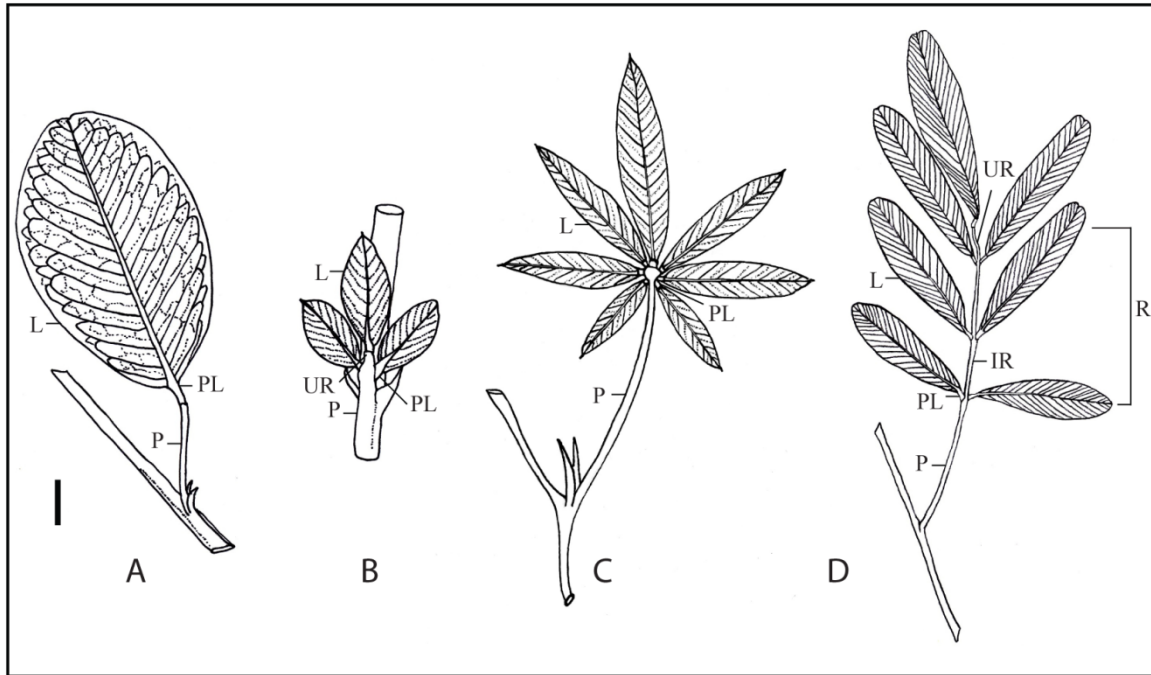
The parts of the leaf discussed below and in the following descriptions are illustrated in Figure 4. In leaf descriptions, the phrases ‘at least some attached in the proximal half’ and ‘all attached in the distal half’ are used to describe the placement of the leaflets. For the purposes of these terms, the ‘leaf’ comprises the petiole, the rachis and the ultrajugal rachis (if present), i.e. the complete spine of the leaf. If the lowest pair of leaflets is attached at a point below half of the spine length, then at least some are attached in the proximal half, if the lowest pair is placed at a point above half of the spine length, then all are attached in the distal half.

It has become apparent during this project that length:width ratios of leaflets will need to be emphasised more in taxonomic descriptions and keys resulting from further research. Leaflet size is very useful, but overlaps between taxa and is influenced by the age of the leaf and local environmental conditions. The relative sizes of the lateral leaflets along the rachis, and between the terminal leaflet and the laterals also requires more attention. In many taxa where the number of leaflet pairs exceeds 20, the position of the largest pair of laterals can be determined quite readily (at the base, towards the middle, at the apex), but in taxa with fewer pairs it is more difficult to assess and appears more variable. In particular, avenues of research within complexes such as the orange-flowered *T. supina* segregates, investigating whether the largest pair is ultimate or penultimate, have proved frustrating.

Leaflet indumentum can be highly diagnostic for some species, yet variable in others, and while a broad view has been taken with taxon circumscription in some descriptions below, this may change in the future when more specimens are available from across species’ ranges, or if they are investigated genetically. Where indumentum has been considered variable, it has not been possible to find clear correlations between this character and others to the point where the recognition of additional taxa is warranted at this stage. For example, variation in indumentum in some taxa can be linked to differences in leaflet size and in both *T. sp. Dunes* and *T. sp. D Kimberley Flora*, there are narrow and broad leaflet forms with similar differences in indumentum. Plants with narrow leaflets generally have fine, appressed hairs on stems, inflorescence rachides and all parts of the leaf, while plants with broad leaflets generally have inclined to patent indumentum. This is not seen in *T. sp. B Kimberley Flora*, however, in which differences in indumentum (upper leaflet surface glabrous vs finely patently hairy) occur across the wide variety of leaflet morphologies (linear to elliptic). The differences between the taxa may be correlated with their distribution and habitat. Both *T. sp. Dunes* and *T. sp. D Kimberley Flora* occur in the Eremaean where a larger leaflet surface area brings with it increased transpiration; a patent indumentum would create a protective/higher humidity layer to reduce this. In *T. sp. B Kimberley Flora*, plants with very narrow leaflets occur in the Pilbara, while broad-leafleted plants are found in the Kimberley and Top End of the NT, where humidity is naturally higher (for a large part of the year); amelioration of transpiration rate through differences in indumentum orientation may not be a factor. This hypothesis has never been tested, but is an interesting proposition and worth considering further. Without field work it cannot be determined whether these differences are significant, nor the degree to which seasonal variation in rainfall and temperature

affect form. Common garden experiments would be a beneficial addition to further taxonomic studies on these variable species.

Some taxa have nearly identical foliage, but are readily distinguishable on flower colour, and the morphology of their fruits and seeds. Sterile specimens may be unidentifiable.



**Figure 4.** Examples of different leaf forms and their parts in *Tephrosia*. A – unifoliolate leaf (*T. coriacea*; A.L. Chapman 1); B – trifoliolate leaf (*T. lasiochlaena*; G.W. Carr & A.C. Beauglehole C 3592 B 47370); C – palmate leaf (*T. clementii*; S. van Leeuwen *et al.* PBS 0260); D – multijugate imparipinnate leaf (*T. rosea*; K.F. Kenneally 6032). P = petiole; R = rachis; IR = interjugal rachis; UR = ultrajugal rachis; PL = petiolule; L = leaflet; lower surface of all leaves shown; indumentum not shown. Scale bar = 10 mm (A, B, D); 5 mm (B). Figure reproduced from Butcher and Hurter (2012).

### Flowers

The species in the genus are broadly divisible into two groups: yellow/orange-flowered and (white)pink/purple-flowered, with Cowie concentrating research on the former and Pedley on the latter. There are correlations between flower colour and other characters such as leaflet venation and the internal structure of the fruit (see Cowie 2004), and the generic boundary of *Tephrosia* and any infrageneric classifications require further work.

Illustrations in Wheeler (1992) show all the flowers in a resupinate position; however, in the majority of species seen in the field in the Pilbara and Gascoyne bioregions, this is not the common state, although has been observed within some inflorescences. It may be more common in the Kimberley taxa, most of which have not been examined *in situ* to date. It may also be related to inflorescence type (axillary vs pseudoracemose). Descriptions of flowers per node include all the flowers in the sequence. While some taxa

do only have a pair of flowers at a node, it is common for the flowers to open sequentially, or for two flowers to open at approximately the same time, with another one or more flowers retained as buds until fruits have formed. For some taxa there are insufficient specimens, or insufficient inflorescences, to allow destructive dissection of contracted structures to properly interpret the arrangement of flowers, bracts and bracteoles. Future field work will target the collection of inflorescences into 70% ethanol, specifically for this purpose.

In *Tephrosia* nine of the stamens have their filaments fused into an open-sided tube, with the tenth (uppermost) stamen free from the others and positioned immediately in front of the standard petal (a.k.a. the vexillum). This is the vexillary stamen and at the base there is typically a gap on either side of the filament between it and the staminal tube; these gaps are termed fenestrae (windows) by Cowie, and it is in this area that callosities (thickenings) and hairs are likely to occur.

### *Fruits*

Fruit morphology is extremely important in the taxonomy of *Tephrosia* and care should be taken to collect fruits in the field to assist with identification. Key characters are whether fruits at maturity are linear or more oblong; whether they are turgid, laterally compressed, or raised above and flattened between the seeds; whether they are straight along their length, upturned just near the apex, or curved along their length; whether the beak (thickened remnant base of the style) is positioned in line with the upper suture of the fruit, or is excentric or central at the fruit apex, as well as its orientation (straight, upturned, downwardly angled, or hooked). Fruit indumentum is consistent in some species and variable in others, and the reasons for this are not known. Many of these characters can be determined from immature or sub-mature fruits, but mature fruits are best, especially because they probably contain seeds, which are also very useful for identification in combination with other characters. Mature fruits can also inform on the colour of spent or absent flowers, fruits having membranous or spongy tissue between the seeds are from orange-flowered taxa, fruits with a smooth inner surface are from pink/purple-flowered taxa.

### *Seeds*

Seed shape is variable in *Tephrosia* (lenticular, globose, obovoid, transversely ellipsoid, transversely obloid etc.); lengths are measured from the hilar side (point of attachment to the fruit wall) to the opposite edge and widths at 90° to that line. No measurements are given for thickness. Some seeds are distinctly flattened, others taper towards the margin. For seeds that are broader than long, the lateral ends can be compressed, such that a rounded edge becomes truncate and the shape and width of the seed become difficult to define. The degree to which this is caused by drying, or damage, or the latitudinal compression of seeds in the fruit if all ovules are fertilised and seed number is high, is unknown. Similarly, the seed coat (testa) of some species varies from smooth to rugose through broadly pitted and this may be related to seed maturity or a consequence of natural drying. The texture of the testa is considered an important diagnostic feature in the segregation of taxa in the *T. clementii* complex. Care must be taken to look at seeds at

maturity to interpret testa texture and seed colour; mottling may be absent or subtle on young seeds.

The colours and patterns on the seeds of *Tephrosia* are highly variable between groups of species and to some degree within species, where all specimens may have mottled seeds but the colours and patterns involved are slightly different. Boldly mottled seeds tend to have contrasting colours in relatively large patches over the testa, while finely mottled seeds have somewhat geometric patterning in multiple colours; seeds are frequently bicoloured in two tones of orange/red-brown and brown, with darker areas in depressions on the seed coat, and often have minute black flecks on uniformly coloured seeds or across mottling. The systematic value of seed and seed coat morphology has been investigated internationally (de Queiroz *et al.* 2013) and SEM (scanning electron microscopy) imagery of the seeds of the WA species is a future direction.

Some species have a large or obvious annular caruncle around the hilum, while others have a small caruncle that sits just inside the hilum; yet others have a minute and often transparent, circle of tissue that, while distinct from the funicle and placenta, does not appear to play a role in biotic seed dispersal. This requires further investigation.

### *Images*

Images, to assist in taxon identification, are provided where possible; many species have not been seen in the field, or have not been photographed in flower, or fruit. Unless otherwise stated, photographs are credited to R. Butcher, Western Australian Herbarium, Department of Parks and Wildlife (©Western Australian Government).

### *Distribution statements*

Distribution statements for taxa refer to *Interim Biogeographic Regionalisation for Australia (IBRA) ver. 7* bioregions and subregions (Department of the Environment 2013), with abbreviations of bioregions in parentheses. Distributions within bioregions are only stated for WA and are derived from *FloraBase* maps (Western Australian Herbarium 1998–) only, because of inconsistencies in AVH related to differences in data delivery, un-curated collections and unreconciled nomenclature between herbaria. Distribution maps are not provided for taxa; *FloraBase* and AVH may be referred to for real-time imagery of geographic ranges.

### *Typification*

Type specimens on loan, or available for viewing through the *Global Plants* initiative (<https://plants.jstor.org/>), have been studied for described allies of phrase-named taxa (where available) and each of the circumscribed taxa. For *T. clementii* and *T. supina* only one specimen (housed at the Herbarium of the Royal Botanic Gardens, Kew (K)) appears to have been used in the original description of the species and is referred to as holotype herein. For *T. sphaerospora*, the specimen at MEL (MEL 630864) that has been designated holotype (by A. Lee 16/1/1974, *in sched.*) does not have the seeds in Mueller's (1883) original description; these can be seen on K 000217136. This, and another type of this name at K, have Mueller's blue labels from the Phytologic Museum

of Melbourne (now State Herbarium of Victoria) bearing the name ‘*Tephrosia sphaerospora* FvM’ in his handwriting, indicating that he distributed them to K following their study at MEL and the description of the species. As such, I am reluctant to follow Lee’s typification without further study of Mueller’s notes and correspondences etc., and refer to all the types I have seen as syntypes (see Glossary).

### ***Descriptive information for re-circumscribed taxa***

***Tephrosia clementii*** Skan, *Hooker’s Icon. Pl.* 28: Tab. 2729 (1905). *Type*: ‘North-Western Australia: between the Ashburton & Yule Rivers. [s. dat.] Coll. Dr E. Clement.’ (*holo*: K 000217115!; *iso*: PERTH 01026844!, fragment from holotype, taken from K by C.A. Gardner, who also copied the drawing accompanying the holotype).

‘*Tephrosia* aff. *clementii* (1) (MET 15,527)’ Trudgen, M.E. & Casson, N., in *Flora and vegetation surveys of Orebody A and Orebody B in the West Angela Hill area...*(1998).

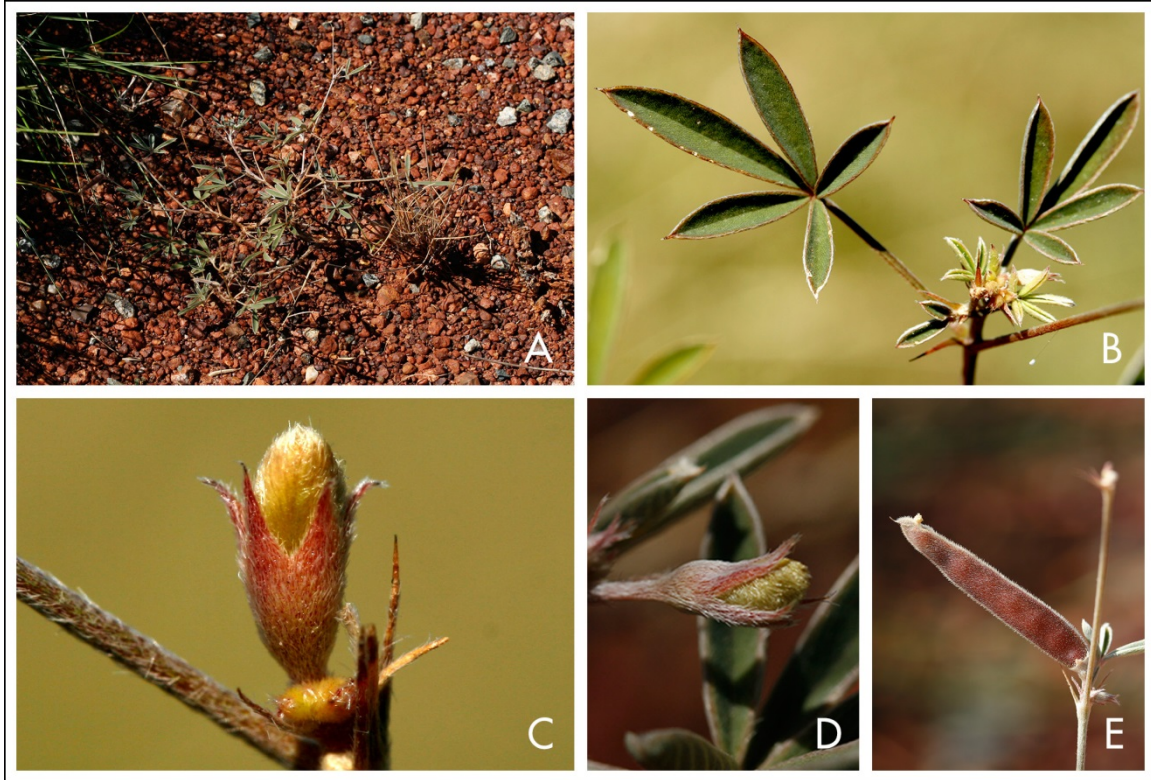
‘*Tephrosia* aff. *clementii* (5)B184’ Trudgen, M.E. & Assoc., in *A flora, vegetation and floristic survey of the Burrup Peninsula...*(2002).

Spreading, woody herb with appressed to inclined indumentum. *Leaves* palmate; *leaflets* (3–)5–7(–9), narrowly elliptic to elliptic to obovate, all in the distal half of the leaf; upper surface glabrous or appressed to patently puberulous, glabrescent; lower surface moderately densely to densely appressed-hairy, secondary veins obscure to visible. *Stipules* persistent, antrorse. *Calyces* with attenuate lobes longer than the tube. *Flowers* small, scarcely opening, pale orange; keel glabrous. *Staminal tube* and *vexillary filament* glabrous, not callused. *Fruit* short, straight, turgid; hairs patent. Seeds sub-orbicular to obovate, light brown flecked with black, smooth or broadly dimpled. (Figure 5)

*Distribution and habitat.* Occurs in WA (PIL). Collected from skeletal and stony sandy loam and clay loam soils, in low to tall, usually open, mixed shrubland with *Triodia* spp. grassland.

*Affinities and notes.* Taxa segregated from *T. clementii* are *T. sp.* clay soils, *T. sp.* Newman and *T. sp.* North West Cape; they are described in the following report. A close relationship with *T. sp.* deserts, segregated from *T. sphaerospora*, is also hypothesised.

Only specimens matching the type and its accompanying illustration are currently included under *T. clementii* at PERTH. For the most part the segregate taxa are readily distinguishable; however, combinations of characters are required to distinguish them (Table 5). This is not unusual in *Tephrosia* where unique combinations of overlapping characters have been used to define species (e.g. Pedley 2014). Of interest is that following the segregation of other taxa, *T. clementii* still displays variation in the density and orientation of indumentum on its stems and leaflets, and even in its presence or absence on the upper surface of leaflets. The high diversity of evidently very closely related taxa in the Pilbara region is intriguing and worthy of further study.



**Figure 5.** *Tephrosia clementii*. A – plant *in situ*; B – palmate leaves; C – flower from top showing division of the upper lip of the calyx; D – flower from side; E – sub-mature, straight fruit (apex malformed; younger fruit on plant clearly straight throughout) showing patent indumentum. Images from R. Butcher & S. Dillon RB 1524. Photographs by R. Butcher.

***Tephrosia sphaerospora*** F.Muell., *S. Sci. Rec.* 3: 128 (1883). *Type citation*: ‘Near the Finke River [Northern Territory], [*s. dat.*,] *Rev. H. Kempe.*’ (*syn*: K 000217137!, K 000217136!, MEL 630864!, MEL 630865!).

Decumbent to low growing *woody herb* with appressed to patent indumentum. *Leaves* pinnate, the terminal leaflet extended by a well-developed ultrajugal rachis; *leaflets* (3–)5–9, (almost always) all in the distal half of the leaf, lanceolate to narrowly elliptic; upper surface with sparse, fine, appressed to patent hairs; lower surface with fine, appressed hairs, secondary venation obscure to visible. *Stipules* persistent, inclined to spreading to reflexed. *Pedicels* stout, to 2.5 mm long. *Calyces* mostly green with the lobes drying grey, the tube *c.* equal in length to the narrowly deltoid lobes. *Flowers* yellow to pale orange, keel with a few hairs along the lower margin near apex. *Staminal tube* and *vexillary filament* glabrous, not callused. *Fruits* linear, straight or more commonly with gently upturned apices, and patent indumentum. *Seeds* subspherical to transversely ellipsoid, testa smooth, boldly mottled in cream/white, orange/orange-brown and dark brown/black; caruncle absent. (Figure 6)





**Figure 6.** *Tephrosia sphaerospora*. A – plant *in situ*; B – leaves, flowers and immature fruits; note extension of the terminal leaflet on a distinct ultrajugal rachis. Photographs © D. Albrecht, used with permission.

*Distribution and habitat.* Occurs in WA (LSD, GD, GSD, CER), SA, NT, Qld and NSW. Infrequently collected in WA, despite occurring over a wide area here and in other States/Territories, presumably because of access issues, infrequent collecting effort in these areas, and the ease with which these small plants could be overlooked. Collected from sand dunes and in loamy soil, in grassland and mulga scrub.

*Affinities and notes.* Type material has been seen and the name is now confidently applied to specimens Australia-wide. The majority of specimens seen at other herbaria identified as *T. sphaerospora* are actually this taxon, while retrospect shows that at the commencement of this project, only a handful of PERTH collections were; it is currently represented by only four specimens. The wide variety of taxa housed under *T. sphaerospora* made its circumscription very difficult for field and identification botanists; this is now resolved. Compared with many other widespread *Tephrosia* in Australia, *T. sphaerospora* is highly morphological consistent across its range and information in the original description (Mueller 1883; in English) which includes reference to ‘thinly-downy’ upper leaflet surfaces, pods ‘moderately compressed’ and seeds that are ‘perfectly spherical, neither angular nor compressed, livid with yellowish brown and blackish spots’, defines it well. Reference to the primary taxonomic literature can often clarify many of the problems that arise through a proliferation of mis-matched specimens under a name.

Following the correct application of the name *T. sphaerospora*, two novel taxa could be segregated from the collection at PERTH, namely *T. sp. deserts* and *T. sp. Newman* (see Table 5); they are described in the following report.

Two taxa that share a number of characters with *T. sphaerospora* are *T. sp. D Kimberley Flora* and *T. benthamii* Pedley (NW NSW/SW Qld; Darling River catchment area and N), and a close relationship between them is hypothesised. They share the distinctive seed morphology described above, have very similar leaf indumentum (same as *T. benthamii*; same as finely appressed-hairy form of *T. sp. D Kimberley Flora*), as well as calyx dimensions. Fruits are also similar to those of *T. benthamii* (*T. sp. D Kimberley Flora* has straight fruit).

**Tephrosia supina** Domin, *Biblioth. Bot.* 89: 201 (1926). *Type*: 'N.W. Australia. Between the Ashburton and De Gray rivers. [*s. dat.*] *Dr E. Clement*' (*holo*: K 000217142!).

*Tephrosia sp.* Pilbara (A.L. Payne PRP 1393), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 12/04/2017].

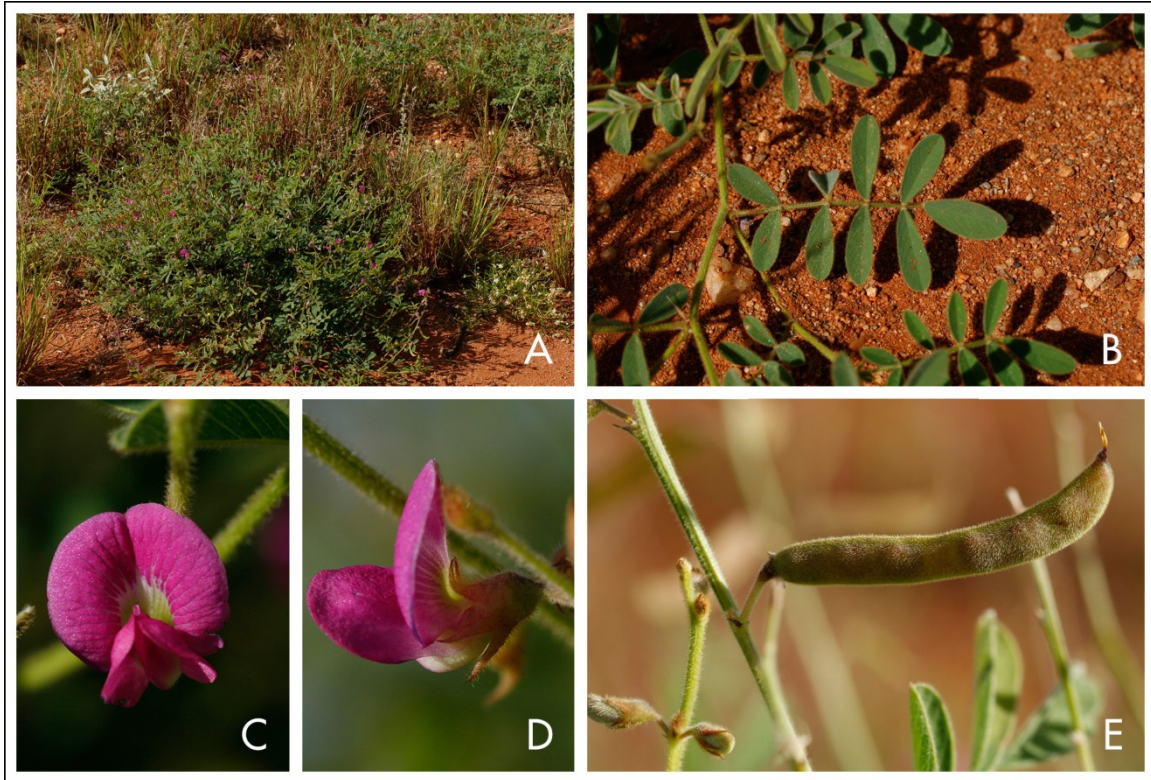
Low, weakly domed *subshrub* with ascending to inclined, stramineous to golden indumentum. *Leaves* pinnate, the terminal leaflet  $\pm$ same size as adjacent laterals, usually extended by a short ultrajugal rachis; *leaflets* 5–11, at least some in the proximal part of the leaf, elliptic to obovate; the upper and lower surfaces with soft, ascending, white to stramineous hairs. *Stipules* persistent, antrorse to inclined. *Calyx* with the lobes deltoid, shorter than to just exceeding tube. *Flowers* pink to purple, keel glabrous, rarely with a few hairs at apex. *Staminal tube* and *vexillary filament* callused near the base with hairs on and in front of callosities. *Fruits* linear, laterally compressed, upturned at apex, beak in line with upper suture, straight, indumentum patent. *Seeds* transversely ellipsoid-reniform, mottled cream-tan and brown, with black flecks and streaks, testa smooth; caruncle very small, white, annular. (Figure 7)

*Distribution and habitat.* Occurs in WA (CAR, GAS, PIL and border with LSD & GSD). *Tephrosia supina* occurs in flat to undulating areas usually associated with watercourses, drainage lines and lower slopes of ridges and hills. Substrate is brown to red-brown sandy loam to red clay; frequently gravelly and often with cracking surface. Bedrock usually comprises granites. Grows in open tall shrubland dominated by *Acacia* species (e.g. *A. ancistrocarpa*, *A. citrinoviridis*, *A. inaequilatera*, *A. kempeana*, *A. pyriformis*) or open to very open low woodland (including *A. coriacea*, *Corymbia hamersleyana*, *Eucalyptus victrix*, *Terminalia canescens*), over low shrubs, grasses, sedges and herbs, or in *Triodia* hummock grassland.

*Affinities and notes.* The concept of *T. supina* has long been confused Australia-wide and this is evident throughout the literature, where the flowers are variously described as pink/purple (Jessop & Toelken 1986), as orange (Maconochie 1981; Wheeler 1992; Paczowska & Chapman 2000; Harden 2002), or as both (Hacker 1990); the original description (Domin 1926) does not provide any flower colour information. The probable holotype of *T. supina* has now been viewed and the name confidently applied to a taxon



occurring in the Pilbara and Gascoyne bioregions of WA. Two similar, purple-flowered segregate taxa have been confirmed as distinct from *T. supina*, namely *T. sp.* Willowra (G.M. Chippendale 4809) and *T. sp.* Magazine Hill (P. Jones 365) [*syn. T. sp.* O.T. Station (S.T. Blake 17659); CHAH 2016], and the differences are discussed under those taxa.



**Figure 7.** *Tephrosia supina*. A – plant *in situ*; B – leaf showing short petiole and terminal leaflet not greatly enlarged; C – flower from front; D – flower from side showing calyx morphology, particularly the deltoid lobes *c.* equal to the tube; E – sub-mature fruit with upturned apex. Images from R. Butcher & S. Dillon RB 1486 (C–E) & 1537 (A, B). Photographs by R. Butcher.

Because it was widely thought that *T. supina* was an orange-flowered taxon, specimens at PERTH now attributed to *T. supina s. str.* had been placed under the phrase name *T. sp.* Pilbara; that is now an informal synonym.

### ***Descriptive information for phrase-named infrataxa***

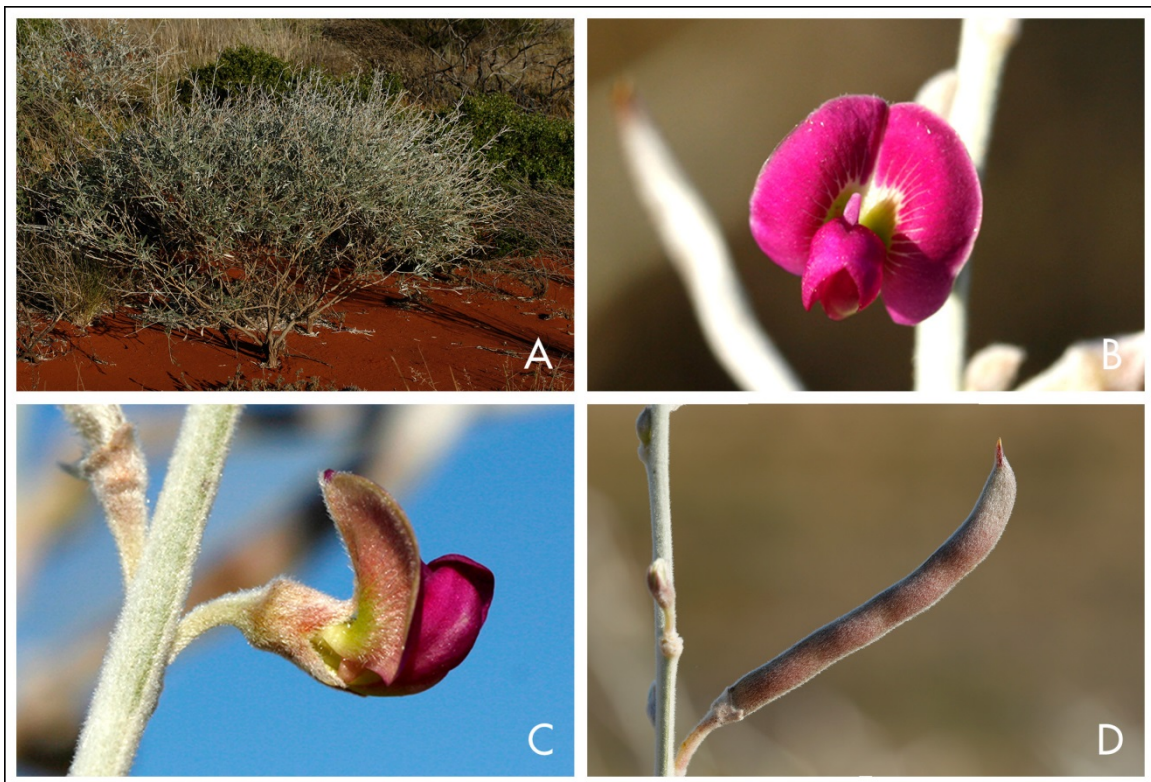
***Tephrosia rosea*** Benth., *Fl. Austral.* 2: 211 (1864). *Syntypes*: Montague Sound, N.W. coast [WA], Sep. 1820, A. Cunningham 270 (K 000217104!, BRI AQ0238555!); Sandy Island, Victoria River [NT], Oct. 1855, F. Mueller *s.n.* (K 000217101!, MEL 630830! (portions marked A)); Depot Creek [NT], 1855, F. Mueller (DNA A0085155! (fragment); MEL 630830! (fragment marked B)). *Possible syntype*: upper Victoria River [NT], 1855–56, F. Mueller (K 000217099!). Not yet lectotypified.

Low, dense *shrubs* to tall, open *shrubs*, with appressed to tomentose, white, grey-white, golden or golden-green indumentum. *Leaves* pinnate, usually extended by a short ultrajugal rachis, petioles short relative to leaf length; *leaflets* characteristically 5–9, but ranging from 1–13 on Kimberley specimens (PERTH), at least some in the proximal part of the leaf, narrowly elliptic through oblong and obovate to cuneate, the apices variable (acute, obtuse, rounded, truncate or emarginate), usually with a very short, but distinct mucro; upper surface indumentum variable, from glabrous and mid-green to finely appressed-hairy to patently hairy to shortly woolly, to densely appressed hairy or tomentose and silver-blue in appearance, venation often reddish; lower surface indumentum variable as for upper, but never glabrous, with closely parallel secondary and intersecondary veins that can be hard to differentiate. *Stipules* usually persistent, antrorse to inclined. *Inflorescences* pseudoracemose, usually elongate, with well-spaced clusters of flowers. *Calyx* with attenuate lobes, shorter than to just exceeding tube. *Flowers* pink to magenta, 7–10 mm long, keel glabrous or with hairs at apex. *Staminal tube* and *vexillary filament* prominently callused near the base with hairs on and in front of callosities. *Fruits* linear, laterally compressed, upturned at apex, beak in line with upper suture or excentric, straight or upturned, the style tardily caducous, indumentum ranging from sparse and appressed to dense and woolly. *Seeds* transversely obloid, finely mottled in various colour combinations, testa smooth; caruncle small, white, annular.

*Notes on typification and named taxa.* Type specimens of *T. rosea* have been viewed by R. Butcher, I. Cowie and L. Pedley, and the following notes are based on observations and discussions between these botanists. The Mueller *T. rosea* syntypes (see above) have greenish, sparsely hairy, retuse to obcordate leaflets with prominent venation while the Cunningham collection from Montague Sound is silvery. Cowie has suggested that this may be the same taxon as Domin's var. *clementii* (type collected between the Ashburton and De Gray Rivers, WA by Dr E. Clement) and that the name should probably be lectotypified on Mueller's Victoria River specimen (this would then be representative of *T. rosea* var. *rosea*).

It is likely that Cowie has viewed only the BRI isosyndrome of Cunningham's collection, which is sterile and has slender, appressed-hairy leaflets similar to var. *clementii*. The K isosyndrome does not match Domin's var. *clementii*; it is a much better specimen (than at BRI) with flowers and fruits, and while the leaflets are appressed-silvery their shape is the same as Mueller's material. Cunningham's collection also clearly has 7–11 leaflets, while the type of var. *clementii* has (3–)5–7 leaflets. Additionally, the fruits on *Cunningham* 270 are of the same proportion and curvature as the Mueller material, and approximate it in the number of developing seeds, which are visible through the fruit wall (*Cunningham*, Montague Sound: 7–10; *Mueller*, upper Victoria River: 6 or 7; *Mueller*, Victoria River: 6–8); Clements' specimen has shorter, less curved fruits with fewer (4 or 5) developing seeds. While lectotypification on Mueller's Victoria River material is undoubtedly the best suggestion, it does not seem likely that *Cunningham* 270 represents Domin's var. *clementii* s. str. As the boundaries of both named varieties are still under investigation, it is equally possible that it belongs to an expanded concept of either or to a novel infrataxon that has not yet been defined. It is worth noting that there are specimens at PERTH that match it and they are currently unplaced (e.g. *C.A. Gardner* 7344, Ord River Gorge; *T. rosea* var. aff. *rosea*, det. I. Cowie 27/01/2011).

Applying Cowie’s concept of var. *rosea*, this taxon would seem to occur in WA from Port Hedland to the Kimberley, including islands across this range, as well as in the NT and western Qld, and can be recognised by the following character combination: erect, open *shrub* to 2 m; *leaflets* obovate, discolourous, upper surface green with hyaline, ascending hairs or glabrous, apex usually truncate to obcordate, occasionally rounded. Comparatively, var. *clementii* also seems to occur in WA, the NT and Qld, but with a more south-westerly distribution than var. *rosea*, and can be recognised by the following character combination: bushy *shrub* to 1 m, with  $\pm$ silvery, densely appressed-hairy stems and leaflets; *leaflets* usually  $\pm$ oblanceolate but also cuneate (if a broad view of the variety is taken), smaller than var. *rosea*,  $\pm$ concolorous, apex rounded to retuse (Figure 8).



**Figure 8.** *Tephrosia rosea* var. *clementii*. A – characteristic shrub habit, with silvery foliage; B – flower from front; C – flower from side showing calyx morphology; D – sub-mature fruit, showing only four seeds developing. Images from R. Butcher & R. Davis RB 1558. Photographs by R. Butcher.

If only these generalised sets of characters are used to define these varieties, then each becomes highly polymorphic with regards to leaf size and spacing, the number and prominence of secondary and intersecondary veins on leaflets, inflorescence length, fruit length and curvature etc. Even with the segregation of the phrase-named taxa discussed below, there are still many specimens that cannot be placed, and a number of intergrades.

A draft key to the named (formal and informal) varieties of *T. rosea* was produced by Dr Russell Barrett as part of his ongoing personal ‘keys to the Kimberley flora’ project, and is reproduced here. It is based on PERTH specimens filed under those names and does

not take into account the large number of specimens filed under *T. rosea* s. lat. or any of the tag names in use during revision (e.g. var. ‘small cuneate leaflets’, var. ‘Halls Creek’, var. ‘Kimberley sericeous’) in the attempt to compartmentalise and understand this species’ variation. It will, however, allow collections that are typical for these varieties to be identified and for those collections that are not typical (i.e. intermediate or with novel forms) to be recognised as such and placed closer to a name (e.g. aff., cf.) than is currently possible.

### **Draft key to the named and informally named varieties of *T. rosea***

(modified from R.L Barrett’s 15/03/2015 draft bibliographic checklist and key to *Tephrosia* in the Kimberley region of Western Australia, itself a modification of Wheeler’s (1992) *Flora of the Kimberley Region* key)

1. Leaflets very narrow, mostly 1.7–5 mm wide, silvery hairy, apex emarginate or obtuse, subglabrous, silvery or golden hairy ..... var. **Napier Range**
- 1: Leaflets broader, mostly 4–15(–20) mm wide, subglabrous, dull grey, silvery- or golden-hairy, apex rounded, emarginate, obtuse or acute (when <6 mm wide)
2. Leaflets (1–)3–7(–9), narrow-lanceolate, subglabrous to sparsely hairy (sometimes densely hairy below on new growth but ±glabrescent), apex acute; pods glabrescent ..... var. **Fortescue Creeks**
- 2: Leaflets (1–)3–9(–11), mostly oblanceolate, usually densely hairy on both surfaces (sometimes glabrescent above in var. *rosea* and rarely in var. Port Hedland), apex usually obtuse or emarginate (sometimes acute in var. *clementii*); pods densely hairy
3. Indumentum ±patent, very dense, almost woolly in appearance... var. **Port Hedland**
- 3: Indumentum appressed to spreading, sparse to dense, but not woolly in appearance
4. Leaflets with indumentum dense, usually obscuring the veins, appearing silvery or golden above; spreading shrub, usually <1 m tall..... var. *clementii*
- 4: Leaflets with indumentum sparse to moderately dense, rarely obscuring the veins, appearing light to dark green above; erect shrub, usually 1.3–2 m tall .....var. *rosea*



## ***Tephrosia rosea* var. *Fortescue creeks* (M.I.H. Brooker 2186)**

*Tephrosia rosea* var. *glabrior* Pedley ms, Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au> [accessed 28 April 2017]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/932712> (CHAH 2011) [accessed 28 April 2017].

Bushy *shrubs*, 0.3–1.4 m tall, 0.3–1.3 m wide, with thinly sericeous, often golden-green stems and rachides. *Leaves* mid- to reasonably dark green, especially on upper surface; *leaflets* (3–)5–7(–9), narrowly elliptic to narrowly oblanceolate, rounded to subacute, sometimes retuse, 11–57 mm long, 3–9 mm wide, upper surface usually glabrous, to thinly appressed-hairy, lower surface finely appressed-hairy, occasionally densely appressed-hairy with white-silver hairs. *Fruits* thinly sericeous, glabrescent, 27–37 mm long, 2.5–3.7 mm wide, with 4–6 seeds. (Figure 9)



**Figure 9.** *Tephrosia rosea* var. *Fortescue Creeks* (M.I.H. Brooker 2186). A – plant *in situ* in dry creek bed; B – flower from front; C – flower from side showing calyx and rachis indumentum; D – immature fruit. Images from R. Butcher & S. Dillon RB 1495. Photographs by R. Butcher.

*Distribution and habitat.* Occurs in WA (PIL, GAS, ?CAR). Found growing in abundance in, and on the edges of, dry creek beds and soak areas, predominantly in the Fortescue subregion of the Pilbara bioregion.

*Affinities and notes.* This is a readily recognisable taxon. The combination of green-bronze indumentum on stems and rachides and narrow, green leaflets that are usually glabrous on the upper surface (cf. yellow-green, grey-green, silvery or silver-blue in other

taxa, usually through indumentum variation), in conjunction with its specific habitat, serve to identify it even when the leaflets do possess hairs (which vary in density, colour and orientation). The distinctly green leaves are most similar to those of var. *rosea*, which also has glabrous or sparsely indumented upper surfaces to leaflets.

A collection at PERTH (*R. Butcher & S. Dillon* RB 1502 A–D) is a population sample showing a large amount of variation in the number (5–9), size and shape of leaflets among adjacent plants in the same habitat.

### ***Tephrosia rosea* var. *Napier Range* (C.R. Dunlop 7760 & B.K. Simon)**

Small, bushy, perennial *herb* or *subshrub*, 0.3–0.5 m tall, 0.5–0.8 m wide, with appressed, white to silver hairs on stems and rachides. *Leaves* appressed-silvery grey, sometimes sparsely so, occasionally with a golden hue; *leaflets* 1–5(–7), narrowly obovate, rounded to truncate to retuse, reflexed with distinct, short mucro, 7–23 mm long, 4–5.5 mm wide, upper surface appressed-silvery hairy, lower surface as for upper. *Fruits* moderately to densely hairy, the hairs appressed to ascending, 29–38 mm long, 2.2–3 mm wide, with (2 or 3[many aborted]–)6 or 7 seeds.

*Distribution and habitat.* Occurs in WA (CEK, border of DAL). Found growing in gritty, red clay soils, skeletal soils and between rock cracks, on plains and lower slopes of valleys in the Napier Range, King Leopold Range, near Winjana Gorge, and in rocky valleys north of Halls Creek. Substrate has been recorded as ‘sandstone adjoining limestone’, granite, and basalt.

*Conservation status.* Listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Smith 2017).

*Affinities and notes.* This is a very distinctive taxon, distinguished from other forms by its short and narrow, apically recurved, silvery grey leaves with 3–5(–7) leaflets, which grade into unifoliolate leaves towards the apices of flowering branches, and then, apparently, into the bracts that subtend clusters of flowers in the pseudoraceme. Flowers occur in the axils of pinnate leaves as well as unifoliolate leaves. The fruits are curved and very slender for their length.

This taxon was placed on the WA vascular plant census as a phrase-named variety of *T. rosea* in light of their obvious similarities and in keeping with the existing taxonomic rank classification established by Domin for var. *clementii*, and continued by Pedley for his ms taxa var. *glabrior* and var. *venulosa*. The voucher specimen for the name has since been found to be the most robust collection; others are extremely fine. Further study may result in this taxon being recognised at species rank.

It has similarities to *T. stipuligera* in the size, shape and curvature of the leaflets, but this species has long, soft hairs on all its parts, much longer, setose, distinctly reflexed stipules, and shorter, straight (±oblong) fruits.

## ***Tephrosia rosea* var. Port Hedland (A.S. George 1114)**

*Tephrosia rosea* var. *venulosa* Pedley ms, Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au> [accessed 28 April 2017]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/746395> (CHAH 2011) [accessed 28 April 2017].

*Tephrosia* sp. Finucane Island (G. Craig 269), M.E. Trudgen, *in sched.* [PERTH].

*Tephrosia rosea* var. Finucane Island (R. Story 8206), L. Pedley, *in sched.* [BRI].

*Tephrosia* '*storyii*', L. Pedley, *in sched.* [BRI].

Small to large, open, sprawling *shrubs*, often considerably broader than tall, 0.4–1.5 m tall, 1–3.5 m wide, with dense, wavy to crisped hairs on stems and rachides. *Leaves* grey-green, dull; *leaflets* 5–7, narrowly obovate to obovate, truncate to emarginate, 25–40 mm long, 10–13 mm wide, upper surface with dense, almost tangled, velvety indumentum, the hairs ascending,  $\pm$ crisped, sometimes sparse or nearly absent (in the same population); lower surface as for upper, never sparse or subglabrous. *Fruits* woolly with ascending to crisped hairs, 20–33 mm long, 22–2.9 mm wide, with 2–5 seeds. (Figure 10)



**Figure 10.** *Tephrosia rosea* var. Port Hedland (A.S. George 1114). A – broad, dull grey-green shrub on Finucane Island; B – leaf with dense, dull indumentum of wavy to crisped hairs; C – flowering branches; D – flowers. Images from R. Butcher & S. Dillon RB 1530 (A, B); S. Dillon, unvouchered (C, D). Photographs by R. Butcher (A, B) and © S. Dillon (C, D), used by permission.



*Distribution and habitat.* Occurs in WA (PIL). Grows in coastal and near-coastal locations from Port Hedland to Point Sampson, with collections also from along the Peawah River, and possibly Warrawagine Station. Occurs in sandy and sandy loam soils, and often tan, deep sands in coastal dunes. While it appears to be a Pilbara taxon, I. Cowie has noted that there are several western NT specimens close to this in habit and indumentum.

*Conservation status.* Listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Smith 2017).

*Affinities and notes.* A targeted regional survey for *T. rosea* var. Port Hedland by environmental consultants from ENV. Australia, in conjunction with BHPBIO-sponsored herbarium botanist, Steven Dillon, determined that populations matching the voucher specimen for this name (A.S. George 1114; set aside as holotype for var. *venulosa* Pedley ms, by L. Pedley) were geographically restricted to within 10 km of the coast in the Port Hedland area (ENV 2011). In the zone 10–15 km from the coast, plants were intermediate with var. *clementii* in indumentum (i.e. hairs wavy but inclined, therefore plants and leaves more silvery than grey).

This taxon is variable in indumentum density between and within populations, with the upper leaflet surface typically woolly, but also thinly hairy with wavy to crisped hairs, to subglabrous (see *R. Butcher & S. Dillon* RB 1529, 1530 & 1531; Finucane Island, same site). The density of indumentum determines the colour of the plants, which ranged from grey (when woolly) to green-grey (when subglabrous), as more of the leaflet lamina is visible.

Hypothesised to be a disturbance specialist, pioneer species and/or post-fire germinant, establishing *c.* 2–3 years after a disturbance event before being out-competed by other vegetation (*c.* 5–7 years) (ENV 2009, 2011).

### ***Descriptive information for phrase-named taxa***

#### **Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)**

*Tephrosia* sp. B, Wheeler, J.R., *Fl. Kimb. Reg.* (1992: 452).

*Tephrosia* sp. Katherine (H.S. McKee 8509), Northern Territory Herbarium [name still in use there, see <http://eflora.nt.gov.au/>]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/932728> (CHAH 2011) [accessed 4 May 2017].

*Illustration.* Wheeler, J.R. *et al.* (1992). *Fl. Kimb. Reg.* p. 444, Fig. 134 E (flower only).

Perennial, erect to spreading, openly branched *shrubs*, 0.5–1.5(–3) m tall, to 3 m wide. *Branchlets, leaf and inflorescence rachides* slender, with sparse to moderately dense, closely appressed, antrorse, pale yellowish hairs 0.1–0.3(–0.4) mm long. *Leaves* pinnate, 100–160 mm long including petiole; *stipules* early-deciduous, erect, straight, very



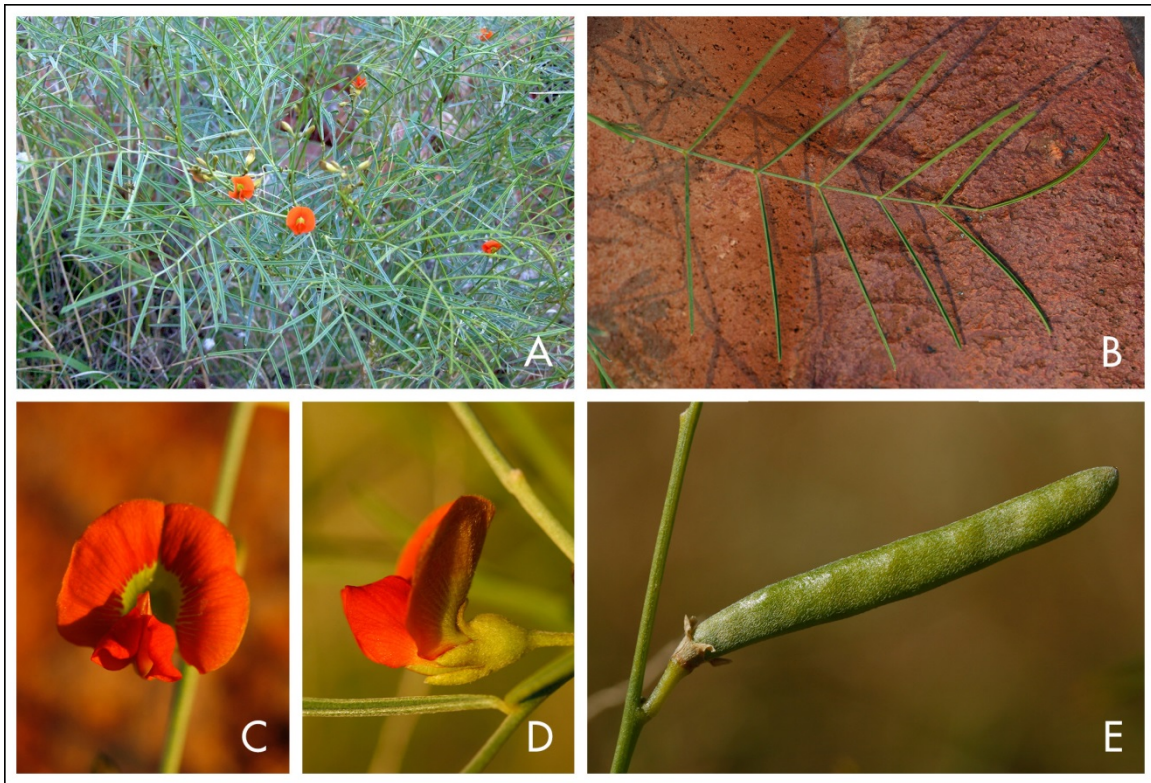
narrowly triangular, 3–6 mm long; *petiole* 14–24 mm long; *ultrajugal rachis* 1–9 mm long. *Leaflets* 5–17, linear to narrowly ovate (rarely narrowly obovate), flat to U-shaped with thickened margins at least when dry, widely spaced, at least some in the proximal half of the leaf, apices acute to obtuse and cuspidate, straight; terminal leaflet 30–75 mm long, 1–6 mm wide; lateral leaflets 30–80 mm long, 1–7(–9) mm wide; upper surface glabrous or with sparse, closely appressed, antrorse, pale yellowish hairs 0.1–0.3(–0.4) mm long; lower surface glabrous or with sparse, closely appressed, antrorse, pale yellowish hairs 0.1–0.3(–0.4) mm long; secondary veins not visible or in 6–18 obscure pairs, intersecondary veins not visible. *Inflorescence* pseudoracemose, leaf-opposed at the apex of branches (sometimes with few flowers in upper leaf axils below inflorescence), 60–260 mm long, with (1–)3(–5) flowers in each cluster; *bracts* deciduous; *bracteoles* deciduous. *Pedicel* 1.8–7 mm long. *Calyx* 3–6 mm long; tube 1–1.7 × the length of lateral lobes; upper lip divided to 25–30% length; lower and lateral lobes triangular, the lower lobe narrower and longer than the laterals. *Flowers* orange, 8.5–9.5 mm long; standard prominently and elongately callused at base, sometimes with a deep pocket above it, apex rounded or retuse; keel glabrous or with a few hairs near lower margin towards apex. *Staminal* tube with minute marginal hairs on and in front of fenestrae, sometimes extending along the entire length of the open tube, calluses present at apex of fenestrae, margins also thickened; vexillary filament with short hairs from callosities to *c.* half its length, thickening in all directions from base to a broad and deep callus with rounded protuberances on the upper and lower surfaces. *Ovules* 8–10. *Pods* linear, straight to slightly upturned at the apex, widely spreading, 30–70 × 3–5 mm, laterally compressed, not to scarcely constricted between the seeds, sparsely appressed-sericeous with yellowish hairs; beak excentric, straight to moderately hooked. *Seeds* 7–9 per pod, 5–5.5 mm between centres, transversely obloid to pulvinate, 2.2–2.6 × 3.3–4 mm, mottled mid- and dark brown, brown and tan, or olivaceous, brown and tan, testa smooth, hilum excentric; caruncle small, whitish. (Figure 11)

*Distribution and habitat.* Occurs in WA (CAR, PIL, DAL, CEK, NOK, OVP, VIB) and the NT. Collections from near Carnarvon (WA) through to Katherine (NT), with a disjunction in WA corresponding with the Great Sandy Desert bioregion and the Pindanland subregion. Very variable in habitat, collected from coastal sand dunes, red sand dunes (swales to midslope), creek beds, and a range of rocky sites including limestone, basalt rockpiles, sandstone pavements and outcropping granite. Associated vegetation communities are also varied, but most commonly collected from low, open woodland or tall, open *Acacia* spp. shrubland over *Triodia* hummock grassland.

*Phenology.* Flowers and young fruits collected across many months, suggesting flowering is initiated in response to localised rainfall events. Flowers observed February, April to August and October; fruits observed May, July to September and December; mature seed observed April, May, July and August.

*Affinities.* *Tephrosia* sp. B Kimberley Flora is superficially similar to *T.* sp. Fortescue and the eastern States species *T. bidwillii*. It can be distinguished from both by its early deciduous stipules (persistent in *T.* sp. Fortescue; persistent, long, lanceolate and leaf-like in *T. bidwillii*), calyx morphology (the upper lobes strongly fused, the tube strongly arched below the upper lip, the lower lobe longer than the laterals, but not to the extent of

*T. bidwillii* – 1/3 to 1/2 × longer than the laterals) and indumentum of short, white to stramineous, appressed hairs (dense, stramineous to ferruginous and patent in the other taxa). It has fruits of similar shape and dimensions to *T. sp. Fortescue*, but they differ in indumentum (sparsely appressed sericeous vs densely appressed- to patently pubescent). *Tephrosia bidwillii* can be further distinguished by its obviously brochidodromous secondary venation with semi-reticulating intersecondary veins (vs veins obscure, when discernible then not brochidodromous) and large flowers (10–17 mm long).



**Figure 11.** *Tephrosia* sp. B Kimberley Flora (C.A. Gardner 7300). A – plant *in situ*; B – narrow-leafleted leaf characteristic of plants in the Pilbara region; C – flower from front; D – flower from side showing calyx morphology; E – immature, straight fruit. Images from R. Butcher & S. Dillon RB 1532 (A–D) & 1535 (E). Photographs by R. Butcher.

*Notes.* Specimens from the Carnarvon and Pilbara bioregions generally have narrower to much narrower leaflets than those from the Kimberley and the NT (which have the broadest). Kimberley specimens show the greatest variation in leaflet width. Specimens with narrow leaflets also tend to have narrower fruits.

### **Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)**

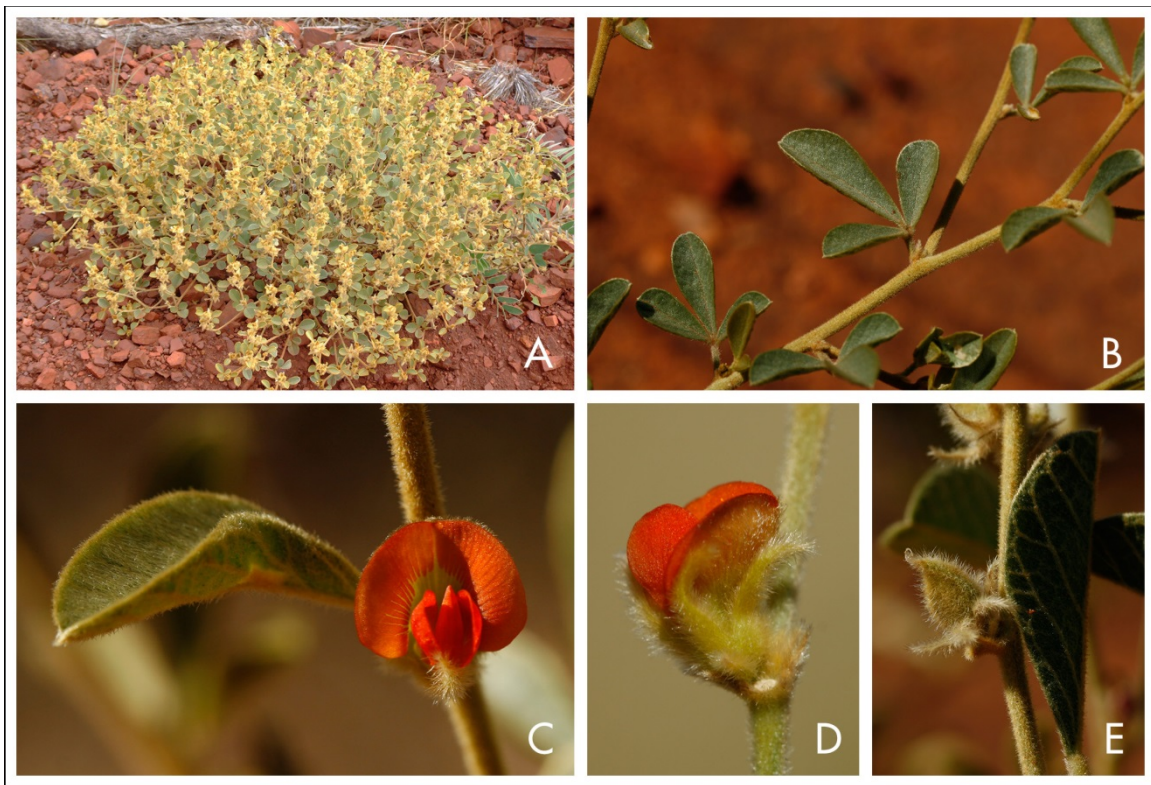
Small, spreading to ascending, multistemmed *shrub* 0.1–0.7(–2) m tall, 0.3–1 m wide. *Branchlets, leaf and inflorescence rachides* moderately to densely hairy with ascending, straight to crisped, white to pale ferruginous hairs 0.3–0.8 mm long. *Leaves* unifoliolate and trifoliolate, commonly transitioning from trifoliolate to unifoliolate towards branch apices, up to 28 mm long including petiole; *stipules* persistent, antrorse, attenuate, 0.7–3.4 mm long; *petiole* 2–9(–16) mm long; *ultrajugal rachis* to 1.9 mm long. *Leaflets* 1 or 3, narrowly to very broadly obovate to suborbicular, flat, all attached in distal half of leaf; apices obtuse to rounded; unifoliolate leaves 10–23 mm long, 4.9–12 mm wide; terminal leaflet 10–22 mm long, 5.5–26 mm wide; lateral leaflets 5–12.1 mm long, 3.8–7 mm wide; upper leaflet surface with a moderate to dense covering of white to stramineous, appressed to ascending, straight to wavy hairs; lower leaflet surface with a moderate to dense covering of ascending, white to stramineous, wavy to crisped hairs; secondary veins brochidodromous, in (4–)5–8(–9) pairs, intersecondary veins reticulate, veins distinctly raised on lower surface of leaflets, not visible on upper. *Inflorescence* fasciculate, axillary, 2–4-flowered; *bracts and bracteoles* persistent. *Pedicel* 0.3–1.3 mm long. *Calyx* 4.7–6.9(8.9–9.5) mm long; tube (0.2–)0.3–0.6 × the length of lateral lobes; upper lip divided to *c.* 95% of length; lower and lateral lobes attenuate to lanceolate. *Flowers* orange, 4.7–8 mm long; standard slightly callused at base, with broadly and shallowly emarginate apex; keel glabrous. *Staminal* tube glabrous near fenestrae, which is slightly callused along margin; vexillary filament glabrous, slightly callused near base. *Ovules* 1. *Pod* obliquely ovoid to broadly and obliquely ellipsoid, laterally compressed, 5–8.7 × 3.5–5.1 mm, indumentum dense, ascending, stramineous; beak central to excentric, deflexed. *Seeds* 1 per pod, obliquely ellipsoid, 2.1–2.7 × 2.4–3.7 mm, uniformly pale brown or also with black flecks, testa smooth, hilum slightly excentric to excentric; caruncle minute, annular, white. (Figure 12)

*Distribution and habitat.* Occurs in WA (PIL, border of GAS, DAL, GSD, TAN, OVP) and the NT. The species occupies a wide range of habitats and has been recorded growing in deep red sand, clayey sand and rocky, skeletal soils, over quartz and ironstone, on sand dunes, floodplains, upper slopes, valley floors and salt-lake margins; occurs in spinifex-dominated grassland, low to tall shrubland, and open woodland.

*Phenology.* Flowering and fruiting from April to October.

*Affinities.* *Tephrosia* sp. Bungaroo Creek is very similar to *T. uniovulata*, both species possessing orange flowers, obovate leaflets with brochidodromous venation and reticulate intersecondary venation, white to stramineous, wavy to crisped hairs on the lower leaflet surface which contrast in colour with the yellow secondary veins, obliquely ellipsoid, one-seeded fruits with an excentric, down-curved beak, and smooth, obliquely ellipsoid, light brown (flecked with dark brown or black) seeds with a minute, white, annular caruncle. *Tephrosia* sp. Bungaroo Creek can be readily distinguished, however, by its axillary fascicles of flowers along main branches (vs flowers in axils of very tightly spaced leaves on leaf-opposed short shoots in *T. uniovulata*), a higher proportion of trifoliolate leaves (vs leaves usually unifoliolate) and more prominent secondary venation on the lower leaflet surface.

*Tephrosia* sp. Bungaroo Creek is also superficially similar to *T. arenicola*. Each of these species can have both unifoliolate and trifoliolate leaves (*T. arenicola* rarely trifoliolate; *T. sp.* Bungaroo Creek frequently trifoliolate, with unifoliolate leaves most commonly subtending axillary clusters of flowers), but *T. sp.* Bungaroo Creek is readily distinguished by its more slender, mostly straight stems with denser leaf arrangement (vs coarse, usually flexuose stems with widely spaced leaves in *T. arenicola*), obovate to broadly obovate leaflets with rounded apices (vs elliptic to ovate leaflets with obtuse apices in *T. arenicola*), longer, more or less sericeous indumentum on the upper leaflet surface (vs short, curled hairs forming a felt-like indumentum in *T. arenicola*), and more prominent secondary and intersecondary venation on the lower leaflet surface (vs secondary venation pattern difficult to determine and intersecondaries obscured in *T. arenicola*).



**Figure 12.** *Tephrosia* sp. Bungaroo Creek (M.E. Trudgen 11601). A – dense, spreading, fruiting plant on road verge (form variable); B – trifoliolate leaves of erect, open plant; C – flower from front, in axil of unifoliolate leaf; D – flower from side showing  $\pm$ sessile attachment, calyx morphology and indumentum; E – single-seeded fruit and unifoliolate leaf showing prominent, brochidodromous venation on the lower surface. Images from R. Butcher & S. Dillon RB 1497 (A), 1523 (D) & 1528 (B, C, E). Photographs by R. Butcher.

## **Tephrosia sp. C Kimberley Flora (K.F. Kenneally 5599)**

*Tephrosia* sp. C, Wheeler, J.R., *Fl. Kimb. Reg.* (1992: 452).

Spindly, open, erect *subshrub*, 0.3–0.8 m tall, width unknown. *Branchlets, leaf and inflorescence rachides* with moderately dense to dense, short, straight, appressed, usually stramineous indumentum, 0.15–0.45 mm long. *Leaves* pinnate, up to 157 mm long including petiole; *stipules* persistent, antrorse at first then inclined 45–80°, attenuate to lanceolate, 1.6–4.7 mm long; *petiole* 13–46 mm long; *ultrajugal rachis* absent. *Leaflets* 13–19, linear, channelled in T.S., some attached in basal half of leaf, apices acute to rounded, deflexed; terminal leaflet 7.2–27 mm long, 0.7–1.8 mm wide; lateral leaflets 7.1–38.5 mm long, 0.6–1.3 mm wide; upper surface sparsely to moderately hairy, hairs appressed, straight, stramineous occasionally also white; lower surface glabrescent (hairs as above where seen), smooth; secondary and intersecondary veins obscured due to narrowness of leaf. *Inflorescence* pseudoracemose, leaf-opposed, 110–320 mm long, with 2–6 flowers in each cluster (often with flowers on short lateral shoots in bract axils); *bracts* persistent; *bracteoles* present at base of pedicels but early caducous. *Pedicel* 2–3.1 mm long. *Calyx* 3–3.5 mm long; tube 1.3–1.9 × the length of lateral lobes; upper lip shortly divided to 19–30(–63)% length; lower and lateral lobes broadly ovate and of equal length. *Flowers* orange, 4.5–6 mm long; standard with very thickened margins to claw, scarcely callused at base, apex emarginate; keel mostly glabrous with a few hairs along the lower margin towards apex. *Staminal* tube glabrous near fenestrae, which are slightly callused on margins; vexillary filament glabrous, slightly callused near base. *Ovules* 4–6, positioned proximally in the ovary with a distal void (void not evident in mature fruits). *Pods* linear, straight, *c.* 42 × *c.* 4 mm, compressed, flattened between seeds; indumentum moderately dense, appressed, white and stramineous; beak in line with upper suture, deflexed. *Seeds* not seen mature, pod observations indicate 4–6 per pod, 5.5–6.5 mm between centres. (Figure 13)

*Distribution and habitat.* Occurs in WA (DAL, adjacent border of GSD). Grows in red sand, loamy sand or sandy laterite among dunes, in open, low vegetation comprising *Acacia* spp., *Eucalyptus* spp., *Grevillea eriostachya*, *Hibiscus* sp., *Newcastelia* sp., and *Triodia* spp.

*Phenology.* Flowers and fruits (immature or with seeds fallen) collected in August and September.

*Affinities.* *Tephrosia* sp. C Kimberley Flora is clearly distinct from all other WA *Tephrosia* taxa, but very similar to the Queensland taxon *T.* sp. Mt Isa (P.L. Harris 277) *s. str.*<sup>3</sup>. While these two orange-flowered taxa are virtually indistinguishable in their inflorescence and vegetative features and have strong similarities in the indumentum and

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<sup>3</sup>Herein meaning the voucher specimen P.L. Harris 277 and collections approximating this (i.e. BRI: Farrell 316, Bradford 15, Wilson 644 & Rowe, Specht 45 & Rogers, Fell 4907, Booth 3586, Schmid 405 & 611, Forster 22172 & 22317 & Booth). There is considerable variation among the specimens identified as *T.* sp. Mt Isa (P.L. Harris 277) at BRI, including both orange- and pink-/purple-flowered collections, and it appears that there are at least two taxa currently included under that phrase name.



dimensions of their calyces, they have a number of differences, which, given their geographic disjunction, leads to them being retained as distinct here. In particular, *T. sp. Mt Isa* has deltoid calyx lobes with the lowermost one longer than the lateral pair, an entire apex to its standard petal<sup>4</sup>, patent hairs on the vexillary staminal filament (in front of the prominent callosities and extending towards the anther over a long distance), hairs near the fenestrae and often on the sides of the staminal tube, 9–11 ovules, patent hairs on the longer (44.5–63 mm long) fruit, and an upturned pod apex. *Tephrosia sp. Mt Isa* also tends to have an ultrajugal rachis (1.5–17 mm long) below the terminal leaflet, although this character has been found to be variable within other taxa. These two taxa also differ in their habitat, with *T. sp. Mt Isa* growing in open woodland (predominantly *Eucalyptus leucophloia*) in rocky soils (quartzite and laterised sandstone) associated with outcrops and hills.



**Figure 13.** *Tephrosia sp. C Kimberley Flora* (K.F. Kenneally 5599). A – flower from front, with shortly ferruginous-hairy bud visible behind; B – dehiscent fruit. Images from G. Byrne 1464. Photographs © G. Byrne, used with permission.

Among the Western Australian *Tephrosia* taxa, *T. sp. C Kimberley Flora* is most similar to *T. sp. sparse pinnae*, from the central and northern Kimberley and the NT, with which

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<sup>4</sup>The voucher specimen *P.L. Harris 277* also has distinct, elongate auricles at the base of the standard petal blade, which are not shared with any of the other *T. sp. Mt Isa* specimens cited above for which flowers were available for study.

it shares orange flowers, linear leaflets and leaves which lack an ultrajugal rachis. *Tephrosia* sp. sparse pinnae can be readily distinguished, however, by the following characters: glabrous to sub-glabrous vegetative parts; shorter petiole relative to leaf length; calyces glabrous or with sparse, white indumentum; large ((37–)45–52 mm long), sub-glabrous to sparsely hairy fruits with a gently upturned to upturned apex and a short, straight beak; 6–8 seeds, each of which bears a white to cream, annular caruncle around the hilum. It is superficially similar to narrow-leafleted specimens of *T.* sp. B Kimberley Flora from the Pilbara and Gascoyne bioregions; the differences are discussed under that taxon.

*Notes.* A cross-reference note written on the outer folder (at DNA) of another species makes mention of a '*T.* aff. sparse pinnae, from Gulf Country' (I. Cowie, *in sched.*) with similarities to *T.* sp. C Kimberley Flora. If this were closely allied to *T.* sp. C Kimberley Flora and closed the morphological and geographic disjunction between this and *T.* sp. Mt Isa, they may be regarded as the same taxon in the future. Until that material is studied and further field work is conducted, it would be premature to consider *T.* sp. C Kimberley Flora and *T.* sp. Mt Isa conspecific, as suggested by L. Pedley, *in sched.*

### ***Tephrosia* sp. Carnarvon (J.H. Ross 2681)**

*Tephrosia gardneri* Pedley ms, Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 4 May 2017].

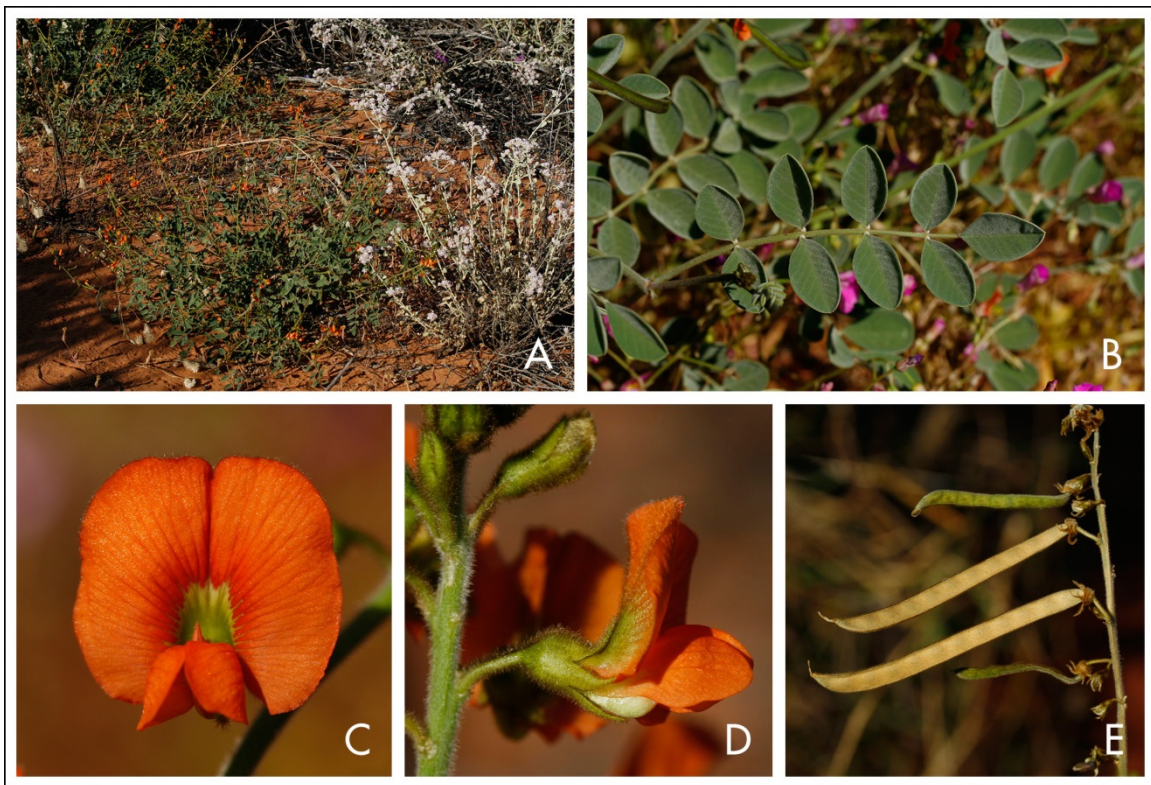
*Tephrosia* sp. Onslow (K.R. Newbey 10571), in *FloraBase*, Western Australian Herbarium, <https://florabase.dpaw.wa.gov.au/> [to be subsumed].

*Tephrosia morrisonii*, *in sched.* [PERTH]

*Tephrosia 'ovaria'*, *in sched.* [BRI]

Ascending to erect, *subshrub* or *shrub*, 0.5–1.5 m tall, to 2 m wide. *Branchlets, leaf and inflorescence rachides* with moderately dense to dense (rarely sparse) indumentum of short, straight, ascending to patent, hyaline and white to stramineous to ferruginous or dark brown hairs, 0.05–0.6 mm long. *Leaves* pinnate, 60–230 mm long including petiole; *stipules* persistent or tardily caducous, antrorse becoming patent and reflexed with age, usually attenuate, occasionally setose or filiform, 2.7–6.7 mm long; *petiole* 12–54.5 mm long; *ultrajugal rachis* 1.5–20 mm long. *Leaflets* (3–)5–13, ovate, obovate or oblanceolate, flat in T.S., at least some attached in proximal half of leaf, apices rounded, retuse, usually straight, minutely mucronate with mucro 0–0.8 mm long; terminal leaflet 11.5–53 mm long, 5–39.5 mm wide; lateral leaflets 9–49 mm long, 4–34 mm wide; upper surface sparsely to densely hairy, the hairs appressed to ascending, sometimes patent, straight, hyaline, silvery or white; lower surface moderately to densely hairy, the hairs appressed to ascending, sometimes patent, straight, hyaline, white, silvery, stramineous to brown on veins; secondary veins craspedodromous to semireticulodromous, in 7–16 pairs, intersecondary veins apparently reticulate, raised but usually obscured by indumentum on lower leaflet surface. *Inflorescence* pseudoracemose, leaf-opposed in a terminal position, 50–300(–400) mm long, with 1–3 flowers in each cluster; *bracts*

caducous; *bracteoles* absent. *Pedice*l 2–6.5 mm long. *Calyx* 3.2–8 mm long, with a dense, patent indumentum of brown to ferruginous, rarely white or stramineous hairs; tube 0.4–0.75 × the length of lateral lobes; upper lip divided to (28–)46–83% length; lower and lateral lobes attenuate. *Flowers* orange to orange-red, 7–15 mm long; standard slightly callused at base, apex retuse; keel glabrous or with very sparse short hairs along the lower margin. *Staminal* tube hairy near fenestrae with hairs concentrated on marginal callosities towards the base; vexillary filament patently hairy on callosities near base. *Ovules* (6–)8–12. *Pods* linear, curved upwards just at apex, 41–52 × 3.5–5(–6) mm, turgid; indumentum dense, patent, white, stramineous, ferruginous or brown; beak in line with the upper suture, straight to upcurved. *Seeds* (2–)6–12 per pod, (3–)3.5–5 mm between centres, transversely oblong, 1.9–3.2 × (1.8–)2.3–5 mm, finely to boldly mottled in orange, brown, pale yellow and green, testa smooth, hilum excentric; caruncle minute, annular, white, within hilum. (Figures 14, 15)



**Figure 14.** ‘Typical’ *Tephrosia* sp. Carnarvon (J.H. Ross 2681). A – low, sprawling plant in near-coastal habitat S of Carnarvon; B – leaf; C – flower from front; D – flower from side showing calyx; E – initiated and mature fruits (with 10 or 11 seeds developing). Images from R. Butcher & R. Davis RB 1544 (A, D), 1547 (B, C) & 1566 (E). Photographs by R. Butcher.

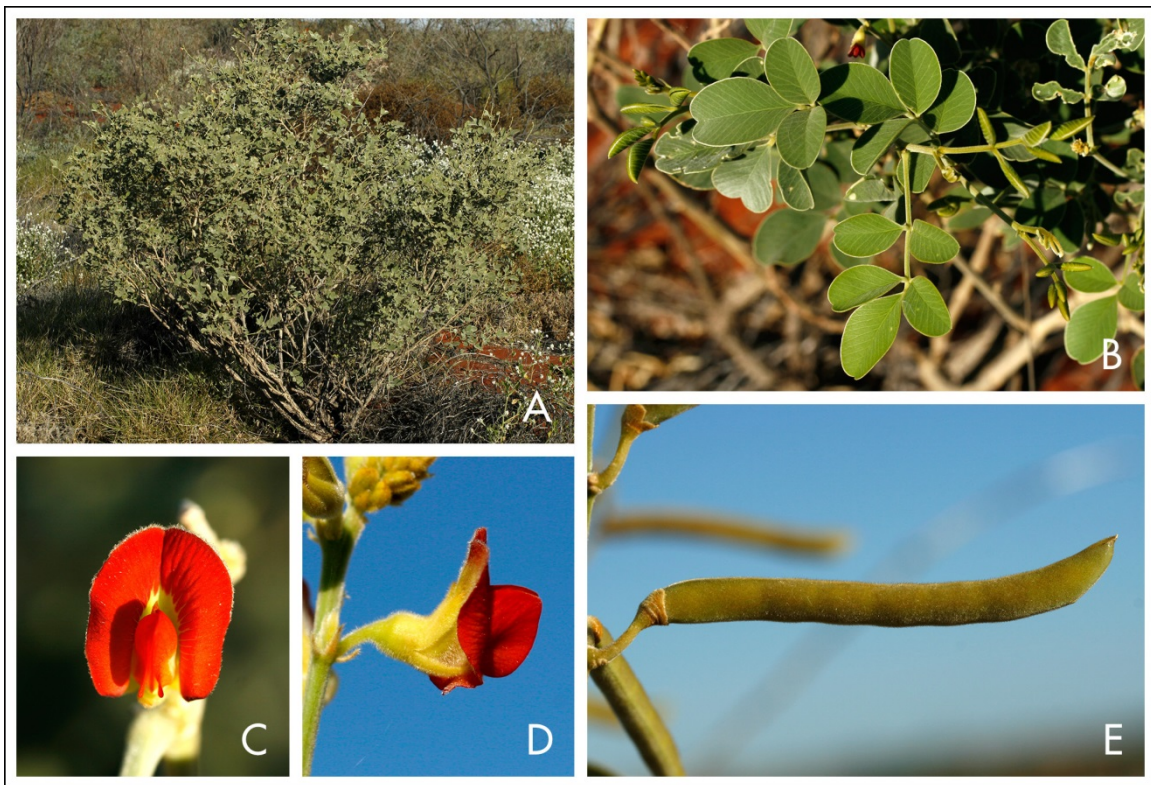
*Distribution and habitat.* Occurs in WA (CAR, GAS, MUR, PIL). Grows in coastal and near coastal dune habitats in pink-brown to red-brown sand, extending inland to dunefields and Aeolian sandplains in pastoral country. Most commonly occurs in tall, open *Acacia* spp. shrubland with *Crotalaria cunninghamii*, *Grevillea stenobotrya* and *Verticordia forrestii* over open *Triodia* spp. hummock grassland, on dunes and plains,



with near coastal vegetation comprising open *Acacia* spp. shrubland with mixed low shrubs and herbs.

*Phenology.* Flowering June to November with fruiting commencing from July; mature fruits with seed observed from August to November.

*Affinities.* In foliage and flower colour, *T. sp. Carnarvon* is similar to the Kimberley species *T. coriacea* and *T. flammea*, and it is from the latter that Pedley first segregated mis-identified specimens of this taxon. Both of these species can be distinguished from *T. sp. Carnarvon* by their unifoliolate to trifoliolate leaves (though *T. flammea* is more variable across its range) and fruits with around 4–6 seeds, with *T. coriacea* notable in having prominently reticulating venation on the leaflets and axillary clusters of flowers, while *T. flammea s. lat.* has longer, more woolly indumentum on leaves, stems and fruits.



**Figure 15.** ‘Typical’ *Tephrosia* sp. Onslow (K.R. Newbey 10571). A – tall, open, woody shrub on dune crest near Onslow; B – leaves; C – flower from front; D – flower from side showing calyx and pale indumentum; E – immature fruit (with 8 seeds developing). Images from R. Butcher & R. Davis RB 1557 (A, C), 1559 (E) & 1563 (B, D). Photographs by R. Butcher.

*Notes.* In December 1984, L. Pedley put determinavit slips on a number of PERTH specimens, marking some as *T. gardneri* sp. nov. and a smaller number as *T. morrisonii* sp. nov. In subsequent years all these specimens were amalgamated at PERTH under *T. gardneri* Pedley ms; the name was never published, later becoming *T. sp. Carnarvon* (J.H. Ross 2681) under APC naming protocols. Later study of the specimens bearing Pedley’s 1984 determinavits identified some subtle characters that appeared to

distinguish his (*in sched.*) names. The name *T. sp.* Onslow (K.R. Newbey 10571) was then erected on the vascular plant census to account for those specimens matching Pedley's *T. morrisonii*, with the following text: "Very closely allied to *T. gardneri* Pedley ms but differing in its shorter, denser stem indumentum; shorter, early-deciduous floral bracts; and caducous stipules. May represent a subspecific taxon with further research." (R. Butcher *in sched.*).

Targeted fieldwork and detailed study of these taxa has failed to find a consistent suite of characters by which *T. sp.* Carnarvon and *T. sp.* Onslow can be distinguished, although the former is very easily recognised. There are certainly trends in morphology that are correlated with location (i.e. southern collections have finer textured leaflets with scarcely raised venation, longer floral bracts that usually exceed the buds in length, larger flowers with a correspondingly higher number (8–12) of ovules and longer, more acute calyx lobes; northern and north-eastern collections have thicker, more densely hairy leaflets with the venation raised on both surfaces and divaricating well-before the margin, shorter floral bracts, frequently smaller flowers with fewer (6–10) ovules and less-elongate calyx lobes) and with habitat (plants from consolidated dunes and Aeolian plains tend to be taller, open, woody shrubs with shorter, denser indumentum, prominent venation and smaller flowers, while plants from near-coastal dunes are smaller and more lush, with longer inflorescences and larger flowers); however, there are numerous intermediate and intergrade specimens that bring together the extremes of form currently recognised under each phrase name. It is the present conclusion that this is likely to be a single species that is variable across its range. The effect of environmental differences on morphology has not been studied and common-garden experiments would be a useful means to investigate patterns of variation further.

As a broadly defined taxon, key characters for its recognition are the leaves with 5–13 flat, ovate through rhomboid to narrowly obovate leaflets; dark indumentum on the inflorescence and often the calyx; deep orange flowers with distinct, caducous bracts; prominent, hairy callosities on the staminal tube and vexillary filament; long, slender, turgid fruits that are upturned just before the apices; transversely oblong seeds that are mottled in many colours and have an excentric hilum with a minute, white, annular caruncle.

### **Tephrosia sp. Central (P.K. Latz 17037)**

*Tephrosia supina* auct. G. Paczkowska & A.R. Chapman, *W. Austral. Flora: Descr. Cat.* (2000: 451), p.p., collections from CR.

*Tephrosia* 'centralis', *in sched.* [BRI] [a.k.a. 'plurijuga', 'multijuga']

Weakly spreading to rounded, *subshrub* to 0.5 m tall, to 0.3 m wide. *Branchlets, leaf and inflorescence rachides* with a moderately dense indumentum of short to long, straight, inclined, patent and declined, white to pale yellow hairs, 0.4–0.9 mm long. *Leaves* pinnate, up to 90 mm long including petiole; *stipules* persistent, usually inclined then deflexed and reflexed with age, lanceolate-attenuate, *c.* 3–7 mm long; *petiole* 10–33 mm

long; *ultrajugal rachis* 1–3 mm long. *Leaflets* (7–)9–15(–17), narrowly obovate to narrowly sub-elliptic, usually folded along the midline, so V-shaped in T.S., at least some in the proximal half of the leaf, apices rounded, straight, sometimes shortly reflexed; terminal leaflet 6.5–27 mm long, 2.2–8.6 mm wide; lateral leaflets 6.2–25 mm long, 2.2–8.5 mm wide; upper surface dull pale green, with short, moderately dense indumentum, hairs patent, straight, white; lower surface grey-green, with moderately long to long, moderately dense indumentum, hairs gently to strongly inclined to sub-patent, straight, white; secondary veins eucamptodromous, in *c.* 5–7 pairs, intersecondary veins obscure, veins cream, raised on the lower surface and usually indistinct on the upper surface. *Inflorescence* pseudoracemose, leaf-opposed at apex of branchlets, 35–85 mm long, with 2 or 3 flowers in each cluster; *bracts* persistent; *bracteoles* caducous. *Pedicel* 2.5–4 mm long. *Calyx* 3.4–3.7 mm long, hairs often white on tube and stramineous on lobes; tube 0.8–0.9 × the length of lateral lobes; upper lip divided to 40–60% length; lower and lateral lobes deltoid. *Flowers* orange, *c.* 5.5–7 mm long; standard not or extremely slightly callused at base, apex rounded to shortly notched; keel usually with hairs at apex, rarely without. *Staminal* tube glabrous, not callused; vexillary filament glabrous, not callused. *Ovules* (5–)6–8. *Pods* linear, very slightly upturned at apex, 30–37 × 3.8–4.2 mm, turgid; indumentum moderately dense to dense, patent to inclined, white to stramineous to ferruginous; beak in line with the upper suture then shortly downcurved. *Seeds* 6–8 per pod, 3–3.5 mm between centres, transversely ellipsoid to sub-globose, 2.1–2.2 × *c.* 2.7 mm, predominantly mottled cream and light orange, with smaller areas of brown and black, testa smooth, hilum central; caruncle absent. (Figure 16)

*Distribution and habitat.* Occurs in WA (CER, adjacent border GSD), NT, SA, Qld. Habitat variable, with *P.K. Latz* 17037 collected from ‘loamy sand, open grassy mulga woodland’ on the WA/NT border *c.* 50 km S of Lake Mackay, and specimens matching it collected from skeletal soil on rocky slopes, and sandy creek beds by rocky outcrops.

*Phenology.* Flowers (few) and fruits occurring on specimens collected from March to October. Probably flowers in response to rainfall events.

*Affinities.* Characteristically, *T. sp.* central is a small, grey shrub with contrastingly straw-coloured stems, rachides and fruits. Its multijugate leaves have obovate leaflets with a high L:W ratio and only 5–7 pairs of secondary veins, which curve before the leaf margin. It belongs to a complex containing *T. sp.* NW Eremaean and *T. sp.* Northern; it is readily distinguished from the former, and mostly so from the latter, even when a broad concept is taken. Identification issues between this and *sp.* Northern are pronounced for sterile specimens, because of the overlap in leaflet number and shape, to a lesser degree, and secondary venation, combined with long, obscuring indumentum.

*Tephrosia eriocarpa* is another grey subshrub with a high leaflet L:W ratio, straight to slightly recurved fruits and *c.* 6, orbicular seeds, but can be readily distinguished by its lower number (3–7) of narrowly elliptic leaflets, the terminal leaflet enlarged relative to the laterals, glabrous upper leaflet surfaces and 8–12 pairs of thickened, oblique secondary veins on the lower surface. It is more similar to *T. sp.* Dunes than to any of the orange-flowered *T. supina* segregate taxa.





**Figure 16.** *Tephrosia* sp. Central (P.K. Latz 17037). A – silvery plant, *in situ* on a small rocky hill at Altunga, E Macdonnell Ranges, NT; B – green plant, *in situ* among rocks on the floor at the entrance to N’Dhala Gorge, E Macdonnell Ranges, NT; C – leaves and sub-mature fruits showing sides of pod indented between seeds. Images from R. Butcher, P. Jobson & R. Davis RB 2117 (A) & 2119 (B, C). Photographs R. Butcher (A, B) & © R. Davis (C), used with permission.

*Notes.* Variation is seen in the appearance of plants in the field (Figure 16 A, B) related to indumentum density and the degree to which the leaves are folded, itself affected by local climatic factors, both of which determine the amount of leaflet tissue visible. Plant condition is another factor.

There are some specimens that are difficult to place with confidence in either *T. sp.* central or *T. sp.* Northern, and the variation in *T. sp.* central may be indicative of additional, unrecognised taxa. The complex requires further study Australia-wide.

### ***Tephrosia* sp. clay soils (S. van Leeuwen et al. PBS 0273)**

Prostrate to semi-prostrate, many-branched, *woody herb*, 0.05–0.30 m tall, to 0.2 m wide. *Branchlets, leaf and inflorescence rachides* pubescent with moderately dense, straight, appressed, white hairs, 0.4–0.8 mm long. *Leaves* palmate, occasionally sub-pinnate on the same plant (with the lowest leaflet pair separated from remainder by an infrajugal rachis 0.5–6 mm long), up to 90 mm long including petiole; *stipules* persistent, antrorse, attenuate, 2.7–8 mm long; *petiole* 20–60(–94) mm long; *ultrajugal rachis* absent. *Leaflets*

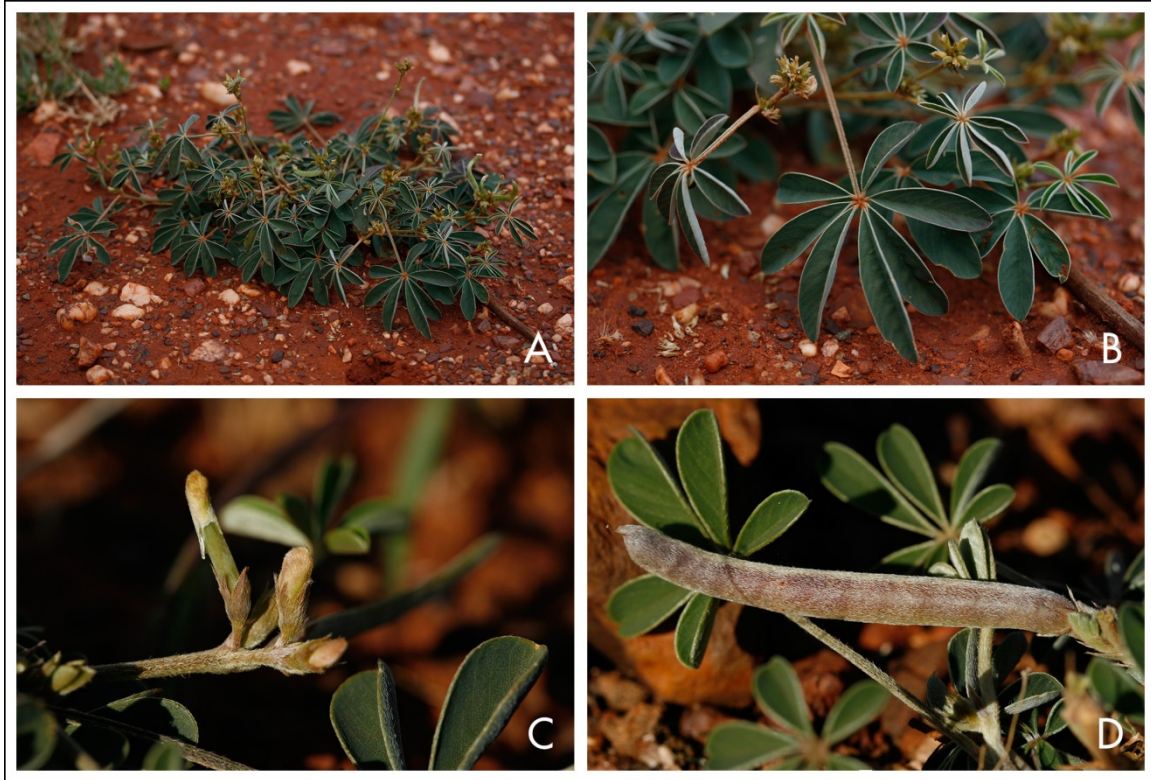
(3–)5–9, narrowly obovate to obovate, flat to broadly V-shaped in T.S., all attached in distal half of leaf, apices obtuse to rounded, rarely retuse, straight; terminal leaflet 22–45 mm long, 4.5–12 mm wide; lateral leaflets 10–24.5 mm long, 4–9 mm wide, longest at apex, adjacent to terminal leaflet; upper surface yellow-green to brownish green, puberulous, glabrescent, or glabrous, hairs (when present) moderately dense, patent, straight, white; lower surface dull light olive green, pubescent, hairs sparse to moderately dense, appressed, straight, white; secondary veins brochidodromous, in 7–11 pairs, intersecondary veins obscure. *Inflorescence* pseudoracemose, leaf-opposed, 32–225 mm long, with 3–5 flowers in each cluster, these frequently crowded on the rachis, axillary flowers also present at base; *bracts* persistent; *bracteoles* absent. *Pedicel* 2.2–3.4 mm long. *Calyx* 3.3–5.1 mm long; tube 0.8–1.5 × the length of lateral lobes; upper lip divided to 72–85%; lower and lateral lobes attenuate to narrowly deltoid. *Flowers* pale orange, 4.7–7(–9) mm long; standard not callused at base or with slight longitudinal thickening above the claw, apex rounded to emarginate; keel glabrous. *Staminal* tube glabrous, not callused, or very slightly thickened on margins of fenestrae; vexillary filament glabrous, slightly thickened towards base. *Ovules* 8–10(–11). *Pods* linear, apex usually strongly upturned, 27–47 × 3.3–4.3 mm, slightly laterally compressed; indumentum moderately dense, appressed, white; beak in line with upper suture to slightly excentric, downcurved, sometimes ±straight. *Seeds* 8–9 per pod, 3.4–3.6 mm between centres, transversely ellipsoid to transversely obloid to reniform with lateral ends frequently depressed, 2.2–3 × 2.6–3.8 mm, uniformly orange-brown to brown through finely black-flecked and mottled in rugae to very dark brown throughout, testa slightly to prominently rugose, hilum central or nearly so; caruncle absent or minute, annular, white-cream. (Figure 17)

*Distribution and habitat.* Occurs in WA (PIL, GAS, MUR). Grows in stony dark red-brown and orange-brown silty clays and cracking clays, on crabhole plains and in clay loams on alluvial floodplains. Most frequently collected from mixed tussock and bunch grasslands with an open to scattered shrub overstorey.

*Phenology.* Flowering and fruit initiation are probably in response to local rainfall events and occur throughout the year. Fully mature fruit with seed have been observed on PERTH specimens collected between April and July.

*Affinities.* As discussed under *T. clementii*, *T. sp. clay soils* is a recently segregated, closely allied taxon. The two share a spreading to prostrate habit, appressed indumentum, palmate leaflet arrangement, a tendency for the upper leaflet surface to turn purple-brown, a similar number of secondary veins per leaflet, pale orange flowers with glabrous keel petals, staminal tube and vexillary filament, these latter organs also not callused.

Key characters distinguishing *T. sp. clay soils* from *T. clementii* include: (usually) longer, somewhat laterally compressed fruits, which have an upturned apex, appressed indumentum and broader, rougher seeds; more closely spaced fascicles of flowers in the pseudoraceme, which also have more flowers per node (*c.* 5 vs 3); and calyx lobes deltoid in outline and *c.* equal in length to the tube.



**Figure 17.** *Tephrosia* sp. clay soils (S. van Leeuwen et al. PBS 0273). A – plant; B – leaves; C – scarcely opening flowers with newly initiated fruit; note short calyx lobes relative to the tube; D – mature, turgid fruit with upturned apex and appressed indumentum. Images from R. Butcher & S. Dillon RB 1503 (A, B) & 1507 (C, D). Photographs by R. Butcher.

*Notes.* The lowest pair of leaflets is sometimes shortly separated from the upper leaflets, which are palmately arranged. This has been observed on specimens from across its range (e.g. A.A. Mitchell 957; S.J.J. Davies s.n. (27/02/1968); S. van Leeuwen et al. PBS 0268; R. Butcher & S. Dillon RB 1503).

The upper leaflet surface varies in colour from yellow-green to green to purple-brown (cf. Figure 17 B, D), with latter two frequently seen on a single plant. This coloration has been seen in other taxa including *T. clementii*, *T. sp.* Newman and *T. oxalidea*.



## **Tephrosia sp. D Kimberley Flora (R.D. Royce 1848)**

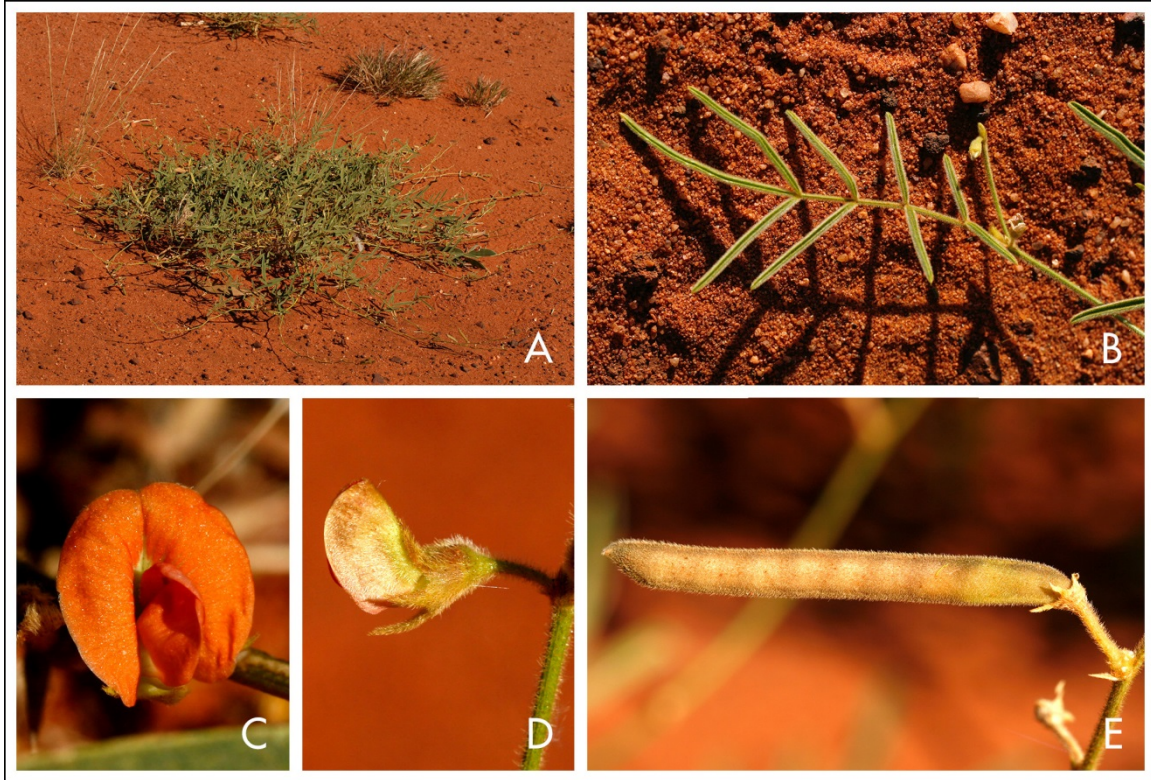
*Tephrosia* sp. D, Wheeler, J.R. *Fl. Kimb. Reg.* (1992: 253–254).

*Tephrosia* sp. Barrow Creek (G.M. Chippendale 921), Northern Territory Herbarium [name removed from census, <http://eflora.nt.gov.au/>]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/7250549> (CHAH 2016) [accessed 4 May 2017].

*Illustration.* Wheeler *et al.* (1992). *Fl. Kimb. Reg.* p. 444, Fig. 134 G (leaf, flower only).

Prostrate to sprawling *perennial herb* or *subshrub*, to 0.3 m tall (with inflorescences), to *c.* 1 m wide. *Branchlets, leaf and inflorescence rachides* with variable indumentum, ranging from sparse, short (0.3–0.5 mm), straight, appressed white or hyaline hairs to dense, longer (*c.* 1.3 mm), straight, ascending to patent, white or stramineous hairs. *Leaves* pinnate, up to 180 mm long including petiole; *stipules* persistent, antrorse at first then quickly reflexed, attenuate to narrowly deltoid, 3–11 mm long, 3–5-ribbed; *petiole* 6–40 mm long; *ultrajugal rachis* 0–2 mm long. *Leaflets* (5–)7–13, linear through oblong to very narrowly elliptic, narrower and new leaflets closely V-shaped in T.S., otherwise V-shaped to flat, at least some in the basal half of the leaf, apices acute to rounded to retuse, straight or deflexed; terminal leaflet 30–92 mm long, 1.6–8 mm wide; lateral leaflets 15–65 mm long, 1.4–4.5 mm wide; upper surface indumentum variable, glabrous to moderately dense, the hairs appressed, fine, straight, hyaline or white, to ascending, coarser, straight, white to stramineous; lower surface indumentum variable, the hairs sparse, appressed, fine, straight and white, to dense, almost patent, coarser, straight to slightly wavy, white to stramineous; secondary veins craspedodromous, brochidodromous just at apex, in 7–11 (on smaller, finely appressed-hairy leaflets) or more commonly 10–14(–17) pairs, intersecondary veins parallel at least at base, veins raised on lower surface (especially broader leaflets), yellowish cream. *Inflorescence* pseudoracemose, leaf opposed, usually with some axillary flowers at the base, to 380 mm long, with 2–5 flowers in each cluster; *bracts* persistent; *bracteoles* absent. *Pedicel* 1.3–6 mm long. *Calyx* 4.1–5.8 mm long; tube 0.59–0.95 × the length of lateral lobes; upper lip divided to (18–)46–65% length; lower and lateral lobes narrowly deltoid, the laterals slightly falcate. *Flowers* apricot to rich orange, 5.2–7.8 mm long; standard scarcely callused to callused at base, apex rounded or very slightly emarginate; keel glabrous or with a few hairs along margin near apex. *Staminal* tube glabrous, fenestrae margins not or rather thickened; vexillary filament glabrous, not callused, broadening a little above base. *Ovules* 8–10. *Pods* linear, straight, 29–43.5 × 3.7–5.2 mm, somewhat compressed laterally to turgid at maturity; indumentum moderately dense, appressed and white, to patent and stramineous; beak in line with upper suture to excentric, deflexed to uncinat. *Seeds* 4–10 per pod, 2.7–4 mm between centres, obovoid or subglobular, occasionally transversely ellipsoid, 2.5–3.6 × 2.2–3.2 mm, orange-light brown with cream-tan mottles and black flecks, testa smooth, hilum central; caruncle absent. (Figure 18)

*Distribution and habitat.* Occurs in WA (PIL, DAL, LSD, GSD, TAN), the NT and Qld (one record, near NT border). Grows in pindan and desert country on flat plains in red sand and clay loams, most commonly in *Triodia* grassland, frequently with a scattered to open overstorey of *Acacia* spp., *Hakea lorea* or *Eucalyptus* sp.



**Figure 18.** *Tephrosia* sp. D Kimberley Flora (1848). A – prostrate plant; B – softly hairy leaf showing linear, V-shaped leaflets (in T.S.) with the terminal leaflet not extended on an ultrajugal rachis; C – flower from front; D – flower from side showing calyx; E – straight, mature fruit. Images from R. Butcher & S. Dillon RB 1521. Photographs by R. Butcher.

*Phenology.* Flowers, fruits and mature seeds collected from end of March to late May, with additional collections in late July and August.

*Affinities.* *Tephrosia* sp. D Kimberley Flora is the same taxon as *T.* sp. Barrow Creek in the NT. The taxon is distinctive in its prostrate habit, leaves with few leaflets and the ultrajugal rachis absent or very short, reflexed stipules, orange flowers with the calyx tube *c.* 2/3 to equal the lobes in length, glabrous stamens, straight fruit with a deflexed to hooked beak, and mottled, sub-spherical seeds. The seeds of *T.* sp. D Kimberley Flora are very similar to *T. sphaerospora* and a number of specimens seen on loan have been identified as *T. sphaerospora* in the past. This can be distinguished by its leaves having a distinct ultrajugal rachis and narrowly ovate to elliptic, acute leaflets, which are all positioned in the distal half of the leaf and have finely appressed-hairy lower surfaces with obscure to faint secondary venation, as well as smaller flowers (to 5 mm long) with more-slender and dark-tipped calyx lobes.

*Notes.* Variable across its range, including within WA where collections from its southwestern extent (Port Hedland area and southward) have fine, appressed indumentum on stems, rachides and leaves, and collections from Broome north-eastward have the indumentum inclined to patent and often tending golden in colour. Similar morphological



variation is also observed among specimens from the NT and does not appear to warrant taxonomic recognition; intergrading specimens also occur.

It has been suggested (L. Pedley *in sched.* & pers. comm.) that *T.* sp. D Kimberley Flora [= *T.* sp. Barrow Creek] is synonymous with *T. benthamii*, itself a replaced synonym of *T. rosea* var. *angustifolia* Benth. (Pedley 1977). Pedley does not provide a description for *T. benthamii* in his publication, instead only citing Bentham's name and type in his synonymy statement. Unfortunately, Bentham does not adequately describe *T. rosea* var. *angustifolia* (Bentham 1864) and the type is a small piece of flowering material with a single juvenile fruit (that cannot be dissected); it is not absolutely clear whether it is a purple- or orange-flowered taxon, although it is clearly different from *T. rosea* s. lat. and warranted recognition as a discrete taxon. A number of orange-flowered specimens from south-western Qld and north-western NSW, in the vicinity of the type locality of *T. benthamii* ('N.S.Wales: Between Darling river and Cooper's Creek, Neilson') are a good match for the type (K 000217106!) in having all the leaflets in the distal half of the leaf, a short but distinct ultrajugal rachis, hairy keel and wing petals, and a gently upturned apex to the slender fruit. Although some specimens of *T.* sp. D Kimberley Flora may have a minute ultrajugal rachis or a few hairs on the lower margin of the keel, they do not have the combination of characters above, and the two taxa are retained as discrete.

About one-third of the specimen records at Australian herbaria currently identified as *T. benthamii*, and delivered to AVH under that name, are *T.* sp. D Kimberley Flora; *T. benthamii* has only been collected from Winton (Qld) southward to the Weilmoringle IPA (NSW) to date. Conversely, the range of *T.* sp. D Kimberley Flora is extended through this study to include a location ('Barkly Downs') in the Burke District of Qld; the distribution of this taxon will be amended in APC.

### **Tephrosia sp. deserts (J.R. Maconochie 1403)**

*Tephrosia* sp. Alice Springs (J.R. Maconochie 1403), Northern Territory Herbarium [name removed from census, see <http://eflora.nt.gov.au/>].

Prostrate, mat-forming *herb*, 0.02–0.03 m tall, 0.3–1 m wide. *Branchlets, leaf and inflorescence rachides* with a sparse to moderately dense indumentum of short, straight, appressed, white hairs 0.3–0.9 mm long. *Leaves* pinnate, occasionally palmate (unifoliolate then trifoliolate at first), up to 93 mm long including petiole; *stipules* persistent, antrorse, attenuate to lanceolate, 2.2–7.7 mm long; *petiole* 11–52 mm long; *ultrajugal rachis* absent. *Leaflets* 3–5, narrowly elliptic to elliptic to oblong, flat to keeled in T.S., all attached in distal half of leaf, apices obtuse to rounded, rarely truncate, straight to deflexed; terminal leaflet 19.5–49 mm long, 3.85–8.4 mm wide; lateral leaflets 16.5–26.2(–39) mm long, 3.4–8.0 mm wide; upper surface yellowish green to light olive green, glabrous; lower surface dull light olive-green to greyish green, with sparse to moderately dense indumentum, hairs appressed, fine, straight, white; secondary veins craspedodromous, in 7–12 pairs, scarcely raised or obscure on lower surface; intersecondary veins reticulate, obscure on lower surface. *Inflorescence* pseudoracemose,

leaf-opposed with axillary cluster at base, to 170 mm long, with 1–3(–4) flowers in each cluster; *bracts* persistent; *bracteoles* absent on pedicels. *Pedicel* (1.6–)2.3–3.3 mm long. *Calyx* 4.4–5.9 mm long; tube 0.4–0.8 × the length of lateral lobes; upper lip divided to 67–77% length); lower and lateral lobes lanceolate, all lobes dark-tipped (calyx below visible through sparser hairs). *Flowers* pale orange, 6–7.5 mm long; standard not callused at base, apex rounded to broadly and shallowly emarginate; keel with hairs along lower margin or in lower 1/3–1/2. *Staminal* tube glabrous, fenestrae not callused; vexillary filament glabrous, slightly thickened above base. *Ovules* 9 or 10. *Pods* linear, rarely narrowly oblong, straight, 22–38.5 × 2.8–4.8 mm, raised above seeds and indented between them to turgid; indumentum moderately dense, patent, white or stramineous; beak in line with upper suture, rarely excentric, usually deflexed. *Seeds* (6–)8–10 per pod, 2–3.5 mm between centres, obovoid to broadly obovoid, 1.9–2.5 × 1.7–2.3 mm, orange-brown with orange area around hilum and brown area around lens, or orange-brown with brown areas or black flecks in depressions, testa smooth to irregularly rugose to broadly dimpled, hilum central; caruncle (?) minute within hilum, annular, white. (Figure 19)



**Figure 19.** *Tephrosia* sp. deserts (J.R. Maconochie 1403). A – prostrate plant at Kiwirrkurra IPA; B – sub-palmate leaf with long petiole; C – scarcely opening flower, showing calyx morphology and indumentum; D – straight, mature fruit. Images from R. Butcher & R. Davis RB 2003 (A) and R. Butcher & S. Dillon RB 1506 (B–D). Photographs by R. Davis (A) & R. Butcher (B–D).

*Distribution and habitat.* Occurs in WA (PIL, LSD, GD, GSD, CER), the NT, SA and Qld. Mostly collected from arid central Australia, extending west to near Jigalong (WA). Occurs in desert country in deep red sands and dune swales, sometimes with limestone

outcropping nearby, in sandplain hummock grassland, sometimes with an open woodland overstorey. Frequently recorded from recently burned areas and described on some labels as 'abundant', 'dominant' or a 'fire-weed' in the post-fire habitat. Associated species include *Aristida inaequiglumis*, *Acacia ancistrocarpa*, *A. melleodora*, *Dysphania kalpari*, *Eremophila macdonnellii*, *Eriachne aristidea*, *Goodenia lamprosperma*, *Ptilotus obovatus*, *P. polystachyus*, *Triodia basedowii*, *T. longiceps*, *T. pungens* and *Halgania* sp. with *Allocasuarina decaisneana* and mulga in the overstorey.

*Phenology.* Flowers observed April, May, July, September and October. Fruits observed April and May, and August to October. Flowering probably in response to rainfall events.

*Affinities.* Segregated from *T. sphaerospora*, and closely allied to *T. clementii*. Both of these species are low-growing subshrubs, with usually narrowly elliptic leaflets, orange flowers and sub-spherical seeds. *Tephrosia sphaerospora* is similar in having pinnate leaves and dark-tipped calyx lobes but can be distinguished by its shortly appressed-hairy or patently hairy upper surface to leaflets, stout pedicels to c. 2.5 mm long, shorter calyx lobes (usually deltoid and c. the same length as the tube), up-turned fruit apex, and the seeds boldly mottled in cream/white, orange/orange-brown and dark brown/black. *Tephrosia clementii* is similar in having elongate pedicels and calyx lobes, glabrous stamens which lack callosities, straight fruits and uniformly light brown to black-flecked seeds, but can be distinguished by its non-mat forming habit, thicker-textured palmate leaves with a higher number of more prominent secondary veins on the lower leaflet surface, usually uniformly coloured calyx and glabrous keel petals.

*Notes.* One specimen (*R. Butcher & S. Dillon* RB 1506) has the majority of leaves palmately divided, like *T. clementii*; the high number of 3-foliolate leaves on the specimen suggests that this was a young plant which may account for this variation.

*Tephrosia* sp. deserts appears to be a post-fire ephemeral, or require disturbance to maintain its populations from a soil-stored seed bank. At Kiwirrkurra (GSD; WA) numerous plants with green foliage, flowers and fruits were found on the graded road embankment, while all plants off the road edge (in an extensive area of buffel grass) were dead.

Like *T. clementii*, *T.* sp. clay soils, *T.* sp. Newman and *T.* sp. North West Cape, *T.* sp. deserts has scarcely opening flowers and fruits begin to form before full anthesis or display of the standard petal. Pollinators have not been observed.

### ***Tephrosia* sp. Dunes (J.R. Maconochie 938)**

*Tephrosia roycei* Pedley ms, *in sched.* [DNA, PERTH].

*Tephrosia* sp. Tanami Desert (P.K. Latz 11978), Queensland Herbarium [not on APC].

*Tephrosia* 'tanamiensis', *in sched.* [BRI].

Prostrate to erect *shrubs* with robust stems, 0.6–1.5 m tall, 0.4–2 m wide. *Branchlets, leaf and inflorescence rachides* with variable indumentum of moderately dense, short, fine, straight, appressed, white hairs [narrow to intermediate forms], to dense, appressed through inclined to patent, undulate, white and stramineous hairs [broad form], 0.2–0.7 mm long. *Leaves* trifoliolate to pinnate, up to 280 mm long including petiole; *stipules* persistent, but possibly caducous when leaflets are broad, antrorse, narrowly to broadly deltoid, hard and sharp [narrow form], 1.6–4.5 mm long; *petiole* 37–105 mm long; *ultrajugal rachis* extended well beyond the uppermost pair of leaflets, 15–33 mm long. *Leaflets* 3–5, variable, linear to elliptic-oblong, flat to V-shaped in T.S., all attached in the distal half of the leaf, apices acute to rounded, sometimes emarginate on broader leaflets, straight; terminal leaflet 26–100 mm long, 2.1–11 mm wide [narrow to intermediate form], 55–68 mm long, 8.2–27 mm wide [broad form]; lateral leaflets 31–89 mm long, 2–9.5 mm wide [narrow to intermediate form], 50–74 mm long, 13–22 mm wide [broad form], terminal leaflet only slightly longer than the laterals; upper surface glabrous [narrow form] or with moderately dense to dense indumentum [intermediate to broad form], the hairs appressed to inclined to patent, straight to wavy, white to stramineous; lower surface indumentum as above; secondary veins craspedodromous, apically brochididromous, in 10–13 pairs, intersecondary veins parallel then broadly reticulating, veins raised on upper and lower leaflet surfaces or obscure on upper surface [narrow form]. *Inflorescence* pseudoracemose, leaf opposed, 135–220 mm long, with 3 or 4 flowers clustered at each widely spaced node; *bracts* caducous; *bracteoles* absent. *Pedicel* 2–4.2 mm long. *Calyx* 5.9–7.8 mm long with a white to bi-coloured (white and golden) indumentum of appressed to ascending hairs; tube 0.52–0.75(–1.04) × the length of lateral lobes; upper lip divided to 59.2–87.5% length; lower and lateral lobes lanceolate to ovate. *Flowers* rusty orange to brick-red with yellow keel, 5.5–8 mm long; standard callused at base, apex truncate to emarginate; keel with some hairs along the lower margin. *Staminal* tube glabrous and position, callused on margins or also at apex of fenestrae; vexillary filament glabrous, callused near base. *Ovules* 6 or 7. *Pods* linear, very gently curved upwards at apex, 27–56 × 3.6–5 mm, ±turgid; indumentum dense, gently inclined to patent, white-golden, or sparser and appressed, white; beak in line with the upper suture, deflexed. *Seeds* 2–6 per pod, 7.25–7.5 mm between centres (of adjacent seeds; many aborted in pods creating gaps), transversely oblong with rounded ends to pulvinate, 2.6–2.9 × 4.8–7 mm, tan-orange brown with subtle light brown mottling darkening to light brown with brown-black patterning, testa smooth, hilum ±central to slightly excentric; caruncle minute, annular, white. (Figure 20)

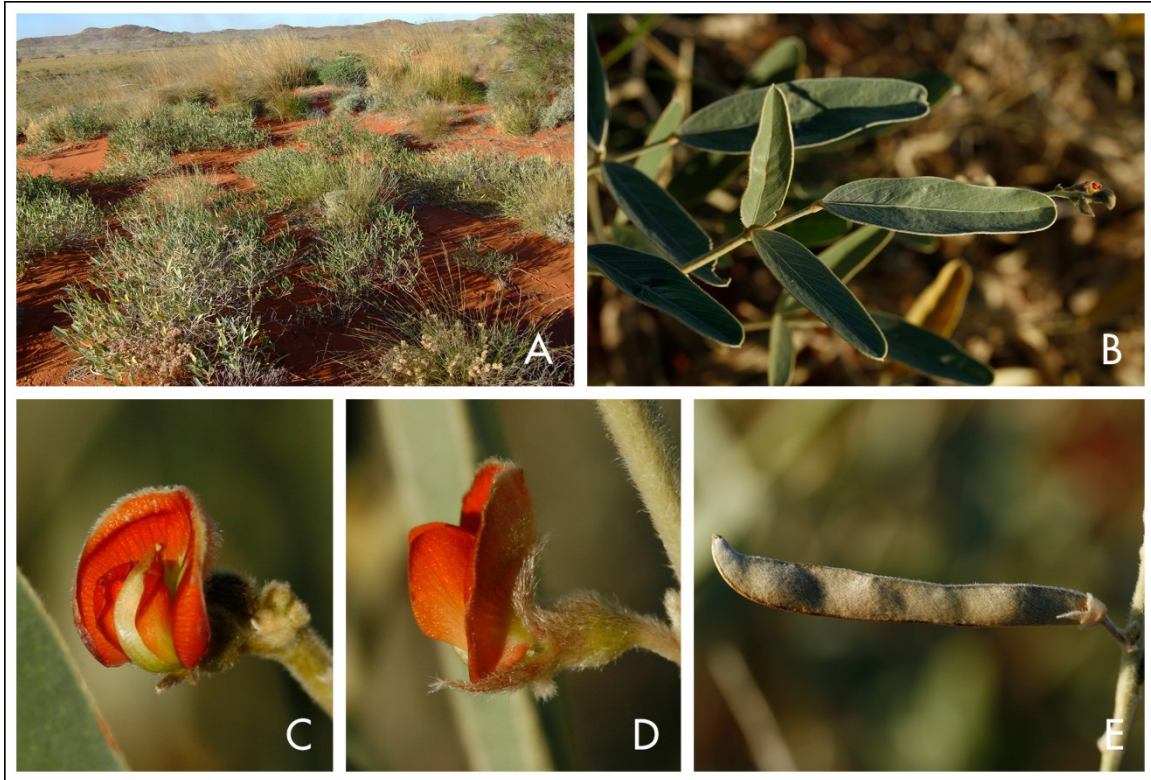
*Distribution and habitat.* Occurs in WA (GSD, GD) and the NT. Extends from west of Telfer, along the Vermin Proof Fence (WA), north-eastward to Sangsters Bore and south-eastward to Lake Amadeus (NT). Collected primarily from consolidated dune crests, in open, low shrubland and grassland (e.g. *Triodia schinzii*) with scattered *Corymbia chippendalei* and tall *Grevillea* shrubs.

*Phenology.* Flowering and fruiting from May to November.

*Affinities.* Similar to *T. sp.* D Kimberley Flora, but this can be distinguished (in WA; see notes under that name for discussion of variation and taxonomic challenges) by its open, prostrate habit; 7+ leaflets; absent or very short ultrajugal rachis; much longer, multi-



ribbed stipules that reflex with age; smaller, sub-orbicular seeds. Plants with narrow leaflets are similar to *T. sp. B Kimberley Flora*, and those with linear leaflets are similar to *T. sp. sparse pinnae*, but each of these has a higher number of leaflets (5–17 and 5–13 respectively). From each of these it can also be distinguished by its calyx, theirs have sparse, appressed hairs and the upper lip notched or shortly divided to *c.* 40%.



**Figure 20.** Broad-leafleted form of *Tephrosia sp. Dunes* (J.R. Maconochie 938). A – low, spreading shrubs on dune crest near Telfer; B – leaves with broad leaflets; C – flower from ±front; D – flower from side showing calyx morphology and indumentum; E – mature fruit with gently upturned apex (3 seeds developing). Images from R. Butcher & S. Dillon RB 1518. Photographs by R. Butcher.

Plants of *T. sp. Dunes* with broad leaflets and dense indumentum on the lower leaflet surface are very similar to specimens of *T. eriocarpa* [not a WA taxon] seen on loan from NSW (*M. Tindale* 6085 & *C. Dunlop*; Katherine, NT), as well as to the K syntype (Desert, Sturts Creek, *F. Mueller*), also on loan. They share long petioles, usually 5, narrowly elliptic leaflets with strongly oblique veins (8–11 pairs in *T. eriocarpa*), calyx morphology, and seed number, and a close relationship must be hypothesised. *Tephrosia eriocarpa* can be distinguished by its densely tomentose-villous indumentum on the fruits and lower leaflet surfaces, the striking contrast in colour between the lower (white-grey, hairy) and upper (brownish green, glabrous to subglabrous) surfaces, longer stipules (5.2–9 mm long), shorter, more oblong fruit with the beak excentric, and cuboid-ovoid, laterally compressed, uniformly dark brown seed 3 × 3.2 mm, with a rugose testa.

*Notes.* Highly variable in leaflet size as currently recognised, with some specimens having linear leaflets with L:W = 50:1–22.5:1 and a glabrous or sub-glabrous upper

surface, and others having flat, elliptic leaflets with L:W = 4.25:1–1.3:1 and the upper surface densely appressed-hairy or densely patent-hairy.

This taxon is also highly variable in habit, as seen in *T.* sp. Carnarvon (incl. *T.* sp. Onslow). Seeing it twice in the field, once at each of its extremes of form, it was difficult to reconcile the two collections as the same taxon, if not for intergrading specimens at PERTH and similar observations by colleagues (I. Cowie, pers. comm.). On dune crests near Telfer (*R. Butcher & S. Dillon* RB 1518), plants were decumbent and c. 0.6 m × c. 2 m, and had broad leaflets, while on dune crests in the Kiwirrkurra IPA (e.g. *R. Butcher & P. Jobson* RB 1991), plants were erect shrubs to 1.5 m tall, and had linear leaflets.

Prostrate, hairy specimens with broad leaflets also lack the short, acute, very hard stipules seen on narrow-leafleted specimens; they are of similar length but are instead broadly deltoid and may be caducous.

### ***Tephrosia* sp. E Kimberley Flora (C.A. Gardner 9937)**

*Tephrosia* sp. E, Wheeler J.R. (1992). *Fl. Kimb. Reg.* (1992: 454–455).

*Tephrosia* sp. Crowded pinnae (C.R. Dunlop 8202), Northern Territory Herbarium [name still in use there, <http://eflora.nt.gov.au/>]; Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au> [accessed 13/04/2017]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/932722> (CHAH 2011) [accessed 4 May 2017].

*Illustration.* Wheeler *et al.* (1992). *Fl. Kimb. Reg.* p. 444, Fig. 134 H (leaf only).

Soft-wooded, perennial, openly branched *subshrubs* 0.4–0.6(–0.8) m high. *Branchlets, leaf and inflorescence rachides* slender, ribbed-quadrangular, variably sericeous to pubescent with sparse to dense, appressed to patent, antrorse, whitish hairs (0.2–)0.4–0.6(–1) mm long, rarely almost glabrous. *Leaves* pinnate, 30–60(–75) mm long including petiole; *stipules* persistent, blackish, firm-textured, erect to spreading, ±straight, narrowly triangular to acicular, 3.5–6.5 mm long; *petiole* (2–)4–6(–8) mm long; *ultrajugal rachis* 0–1 mm long. *Leaflets* (9–)19–35, (elliptic to) obovate, flat to slightly and broadly channelled above with thickened margins, closely spaced including in the proximal half of the leaf; apices obtuse and excentrically- or recurved-cuspidate; terminal leaflet 3–15 mm long, 1–5 mm wide; lateral leaflets 6–22 mm long, 1–5 mm wide; upper surface sparsely appressed-pubescent to densely spreading-sericeous with antrorse, whitish hairs 0.4–0.6 mm long, rarely ±glabrous; lower surface with indumentum as for upper; secondary veins obscure or in 2–4 pairs; intersecondary veins obscure. *Inflorescence* pseudoracemose, leaf-opposed at the apices of branches, 100–260 mm long, with widely spaced (2)3-flowered clusters; bracts and bracteoles persistent. *Pedice*l 1–3 mm long. *Calyx* 2.5–4 mm long; tube 0.6–1 × the length of lateral lobes; upper lip divided to 30–50% length; lower and lateral lobes triangular, the lower lobe slightly to much longer and narrower than the laterals. *Flowers* orange, 5.5–7.5 mm long; standard linearly callused at base, apex emarginate; keel glabrous. *Staminal* tube glabrous, margins of the small fenestrae somewhat callused (thickened); vexillary filament glabrous, geniculate near

base and thickened in this region. *Ovules* 8–10. *Pods* linear to narrowly obovate, upturned at the apex, widely spreading, (25–)40–60 × 3–4 mm, laterally compressed, not to scarcely constricted between the seeds, sparsely appressed-sericeous to spreading-pubescent with whitish hairs; beak excentric, straight to distinctly hooked. *Seeds* (4–)6–7 per pod, 5–6 mm between centres, laterally compressed, transversely obloid-ellipsoid, 2–2.2 × 3–3.6 mm, dull olive-brown or light brown usually with darker mottling, testa smooth, hilum excentric; caruncle absent. (Figure 21)

*Distribution and habitat.* Occurs in WA (CEK, NOK, VIB), the NT and Qld. In the Kimberley, this taxon is often on rocky slopes and in open woodland, in scattered localities from Osborne Island and Drysdale River National Park southward to the Lennard River (Wheeler 1992).

*Phenology.* Flowering peaking in January and February with fruiting commencing in March and fruits reaching maturity in May; mature seeds mostly seen on collections from May.

*Affinities.* *Tephrosia* sp. E Kimberley Flora is very closely allied to *T. subpectinata* and the two can be very difficult to distinguish. In general, *T. sp. E Kimberley Flora* can be distinguished by the combination of its smaller, more numerous, usually obovate leaflets with a L:W ratio of *c.* 2:1–5:1 (vs 7–17 pairs; ±linear; L:W ratio 4:1–10:1 in *T. subpectinata*). The leaflet lengths of both taxa overlap somewhat and it is on the voucher specimen for the name, *C.A. Gardner* 9937, that the longest leaflets are seen; it is the most like *T. subpectinata* in foliage of all the specimens of *T. sp. E Kimberley Flora*.

Superficially similar to *T. polyzyga*, but this species is readily distinguished by its more numerous, silver-grey, hairy, ±elliptic leaflets with prominent brochidodromous venation on the upper leaflet surface, yellow flowers with the calyx densely appressed-hairy, and patently hairy fruits with an excentric to almost central beak and the margin constricted between the seeds.

Some collections of *T. remotiflora* (separated at PERTH as *T. aff. remotiflora*) approximate *T. sp. E Kimberley Flora* in their numerous, densely arranged, hairy leaflets with recurved apices, but *T. remotiflora* is a pink-flowered species, so they are readily distinguished when flowers or fruits are available for study.

*Notes.* This taxon is very variable with respect to leaflet shape and size. The boundaries between *T. sp. E Kimberley Flora* and *T. subpectinata* will be the subject of a morphometric study under the ABRS grant.

The key to species in Wheeler (1992) uses a pod width character to separate *T. sp. E Kimberley Flora* (3–4 mm wide) from *T. subpectinata* (2–2.5 mm wide); this difference has not been observed in any material seen; both taxa have fruits of the same dimensions.





**Figure 21.** *Tephrosia* sp. E Kimberley Flora (C.A. Gardner 9937). A – erect, rounded shrub *in situ*, among sandstone rocks above waterhole; B – multi-jugate pinnate leaf, note that these are from the apex of the branch and that the lower leaves had broader, oblong, more widely spaced leaflets; C – mature fruit with upturned apex. Images from R. Butcher & A.N. Start RB 1869. Photographs by R. Butcher.

### ***Tephrosia* sp. F Kimberley Flora (B.R. Maslin 5139)**

*Tephrosia* sp. F, Wheeler, J.R., *Fl. Kimb. Reg.* (1992: 455).

*Tephrosia* sp. Sinuate (T.G. Hartley 14337), Northern Territory Herbarium [name removed from census, see <http://eflora.nt.gov.au/>]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/7253605> (CHAH 2016) [accessed 7 May 2017].

*Tephrosia sinuolata* Cowie ms, de Kok, R.P.J. & Biffin, E. *The Pea Key* (2007); *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/932717> (CHAH 2011) [accessed 7 May 2017].

*Illustration.* Wheeler, J.R. *et al.* (1992). *Fl. Kimb. Reg.* p. 453, Fig. 137 H (fruiting branch only).

Erect, compact *subshrub*, recorded as 0.3 m tall, 0.7 m wide (1 record). *Branchlets, leaf and inflorescence rachides* with moderately dense, moderately long, straight to gently curved, patent to ascending, white hairs to 0.7–1.1 mm long. *Leaves* trifoliolate or pinnate, up to 32 mm long including petiole; *stipules* persistent, very prominent, antrorse at first then reflexed with age, subulate and stiffly setaceous, 7–10 mm long; *petiole* 4.8–10.5 mm long; *ultrajugal rachis* 0–1 mm long. *Leaflets* 3–7, narrowly obovate to obovate, flat in T.S., at least some attached in the basal half of the leaf, apices rounded to



deeply emarginate, straight, with a prominent mucro 1.5–2.2 mm long; terminal leaflet 14–20 mm long, 8–9.5 mm wide; lateral leaflets 12.9–19.5 mm long, 5.6–7.6 mm wide; upper surface light green, drying brown, sparsely hairy or glabrous, hairs ascending, wavy; lower surface light green, drying brown, sparsely to moderately hairy, hairs spreading, wavy, longer than upper surface, white; secondary veins brochidodromous, in 7–9 pairs, intersecondary veins openly reticulate, midvein prominent, raised, yellow-tan. *Inflorescence* fasciculate in axils or pseudoracemose and axillary or leaf-opposed, *c.* 10 mm long, with 2–4 flowers in each cluster; *bracts* persistent; *bracteoles* absent or caducous. *Pedice*l 2.5–6.5 mm long. *Calyx* 5–9.1 mm long, sparsely pilose; tube 0.26–0.45 × the length of lateral lobes; upper lip divided to 56–68% length; lower and lateral lobes narrowly triangular to subulate, with prominent midrib, lower lobe longer than laterals. *Flowers* orange or yellow-orange, 7.5–10 mm long; standard claw callused at base, apex shallowly emarginate; keel glabrous. *Staminal* tube glabrous, slightly callused on margins of fenestrae near base; vexillary filament glabrous, not callused. *Ovules* 3 or 4(–?), evenly distributed; *style* flattened, tapering; *stigma* surrounded by long hairs. *Pods* narrowly oblong to oblong, straight but with margin sinuous, 23–27 × 4–4.5 mm, compressed, indented between the seeds; very sparsely to sparsely pilose, hairs spreading, white, to 1.5 mm long; beak excentric to central, angled downwards, style tardily caducous. *Seeds* not seen mature, 2–5 per pod, 4.5–4.8 mm between centres, apparently pulvinate, *c.* 2.4 × 2.15 mm, uniformly brown, testa apparently pitted, hilum central; caruncle absent. (Figure 22)

*Distribution and habitat.* Occurs in WA (VIB, CEK) and the NT. Infrequently collected from savannah woodland between Pentecost Downs and Kununurra (WA), with one collection from Keep River National Park in the NT.

*Phenology.* Flowering January to March; fruiting February to May.

*Affinities.* *Tephrosia* sp. F. Kimberley Flora is a very distinctive species and can be characterised by its leaves having 3–7 leaflets, each narrowly obcuneate with a strongly emarginate apex and an extremely pronounced apical mucro, as well as long and thread-like stipules and floral bracts, very long calyx lobes relative to the tube, and a ±oblong fruit with the beak positioned excentrically to centrally (similar to *T. phaeosperma*), with the style falling very late.

The only other taxa in WA with a long mucro at the apex of each leaflet are *T. macrocarpa* and *T. stipuligera*. The former is also orange-flowered and has leaves that sometimes dry reddish to brown, but *T. macrocarpa* is readily distinguished by its leaves which have caducous stipules, long (2.5–4.5 mm), wrinkled petiolules, a distinct ultrajugal rachis (8–10 mm long) and numerous pairs (15–25) of secondary veins on the leaflets, as well as its fruits, which are linear (45–55 × 4.5–5 mm) with the beak in line with the upper suture and straight, and have 7–9, mottled, arillate seeds. Despite also having long, thread-like stipules, softy hairy, narrowly obovate leaflets and oblong, 4-seeded fruits, *T. stipuligera* cannot be confused with *T.* sp. F Kimberley Flora, having instead pink-purple flowers, less than half the size, and straight (vs sinuate) margins to its fruits.



**Figure 22.** *Tephrosia* sp. F Kimberley Flora (B.R. Maslin 5139). A – dense, compact shrub N of Doon Doon; B – flowers and developing fruits (with deflexed style) in axils of apical, unifoliolate leaves with emarginate, mucronate apices. Images from G. Byrne 3081. Photographs © G. Byrne, used with permission.

### ***Tephrosia* sp. Fortescue (A.A. Mitchell 606)**

*Tephrosia bidwillii* Benth. var. *densa* Benth., *Fl. Austral.* 2: 210 (1864). *Type:* ‘N. Australia. Hills near Nichol Bay, F. Gregory’s Expedition.’ (*holo:* K 000217093!).

*Tephrosia densa* (Benth.) Pedley ms. Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 04 May 2017].

*Tephrosia* sp. Meentheena (S. van Leeuwen 4479), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [change not made as of 04 May 2017].

*Tephrosia* sp. dense (A.C. Beaglehole 11456), Northern Territory Herbarium, *in sched.* [not on APC].

*Subshrubs* to *shrubs*, 0.2–1.4 m tall, 0.2–1.2 m wide. *Branchlets, leaf and inflorescence rachides* with a moderately dense to dense indumentum of short, straight, appressed to patent, white to stramineous to ferruginous hairs, 0.1–0.9 mm long. *Leaves* pinnate, 58 to 185 mm long including petiole; *stipules* persistent, antrorse, attenuate, 4–13.5 mm long; *petiole* 6–30 mm long; *ultrajugal rachis* 0–8 mm long. *Leaflets* (5–)7–17, narrowly lanceolate to narrowly elliptic, flat to V-shaped in T.S., at least some in the proximal half of the leaf, apices acute to rounded, straight or slightly deflexed; terminal leaflet 21–58 mm long, 3–10.1 mm wide; lateral leaflets 17–60 mm long, 2–10 mm wide; upper

surface glabrous or puberulous, hairs patent, fine, straight, hyaline, white; lower surface moderately densely to densely pubescent, hairs appressed, straight, white or less commonly stramineous; eucamptodromous, apically brochidodromous, in 7–15 pairs, intersecondary veins obscure, secondary veins often raised on the upper surface of the leaflets as well as the lower. *Inflorescence* pseudoracemose, leaf-opposed, 42–270 mm long, with 2–5 flowers in each cluster; *bracts* deciduous, rarely persistent; *bracteoles* deciduous. *Pedice*l 1.3–5.8 mm long. *Calyx* 3.5–6.9 mm long; tube 0.6–1.2 × the length of lateral lobes; upper lip divided to 20–60% length); lower and lateral lobes narrowly deltoid to attenuate. *Flowers* orange, 8–11 mm long; standard not or slightly callusing at base, apex rounded to retuse; keel frequently with hairs along the lower margin. *Staminal* tube glabrous, rarely hairy (e.g. *M.E. Trudgen* 16176) with short hairs present on margins of tube or on the sides near the tube apex (e.g. *B.R. Maslin* 4707), margins of fenestrae thickened to callused; vexillary filament glabrous or rarely patently hairy from middle of callosity to c. 2/3 filament length (see *A.C. Beauglehole* 1456; *M.E. Trudgen* 16176), callused near base. *Ovules* (5–)6–10. *Pods* linear, straight with apex slightly upturned, 26–65 × 3–4.5 mm, turgid; indumentum moderately dense to dense, appressed, inclined or patent, white, stramineous, ferruginous or brown; beak in line with upper suture, straight to slightly inclined. *Seeds* 5–9 per pod, 4–6 mm between centres, transversely obloid-ellipsoid, 1.7–3.2 × 2.3–4.2 mm, finely mottled in combinations of olivaceous, light brown, brown, red-brown and black, the hilum encircled with green then orange, testa smooth or broadly dimpled, hilum excentric; caruncle minute, annular, white, in hilum. (Figure 23)

*Distribution and habitat.* Occurs in WA (GAS, PIL, adjacent areas of LSD, GSD). Habitat variable. Grows in red-brown gritty to stony clay loams, sandy loams and loams, usually in association with rocks (granite boulders, quartz hills, basalt rockpiles, silcrete/limestone). One collection from a low coastal dune in pale brown coarse sand (*D.J. Edinger* 5978 C; Giralia Station; specimen has very slender leaves and is in bud only, but ID appears correct). Grows in open tall shrubland or open low *Acacia* woodland with low shrubs and tussock grassland, or *Triodia* hummock grassland with scattered *Corymbia* or *Eucalyptus*.

*Phenology.* Flowers observed March to August, with fruits and seeds collected May to September.

*Affinities.* *Tephrosia* sp. Fortescue is similar to collections of *T.* sp. B Kimberley Flora having broader leaflets (mostly Kimberley and NT specimens), but that taxon can be distinguished by its early deciduous stipules, sparsely appressed-sericeous indumentum on calyces and fruits, the calyx being strongly curved on the adaxial surface, the standard petal having prominent, elongate callosities at the base and the vexillary filament thickening in all directions from the base and having rounded protuberances on the upper and lower surfaces. Investigation of the status of *T. bidwillii* in WA found that while there was superficial similarity between the two taxa, *T.* sp. Fortescue was a clearly different species (rather than a variety of *T. bidwillii*, as suggested by Bentham in 1864); the differences are discussed in Butcher (2012), with some key characters for recognising *T. bidwillii* provided under the *Affinities* for *T.* sp. B Kimberley Flora.



*Notes.* Although this taxon has a validly published name (*T. bidwillii* var. *densa*), the decision by Pedley (*in sched.*) to recognise this as a new taxon at species rank (*T. densa* Pedley ms) has been reflected in the phrase name, which replaced the manuscript name under APC protocols (see CHAH 2014).

The type specimen of *T. bidwillii* var. *densa* comprises two small pieces, evidently taken from the upper part of the plant, with leaves, flowers and just initiated fruits. The specimen is densely-flowered and has rufous indumentum on the inflorescence and floral parts; the leaves have 11–17 leaflets, which are glabrous on the on the upper surface with thick, raised secondary veins. Numerous specimens at PERTH match this form.



**Figure 23.** *Tephrosia* sp. Fortescue (A.A. Mitchell 606). A – openly branched shrub; B – leaf showing well-spaced leaflets with glabrous upper surfaces, the spacing and indumentum of the leaflets is variable; C – flower from front; D – flower from side showing calyx morphology and stramineous indumentum, the colour of the indumentum is variable, to dark ferruginous; E – mature fruit showing gently upcurved apex. Images from R. Butcher & S. Dillon RB 1487 (A, B, D) & 1490 (C, E). Photographs by R. Butcher.

Variation in this species includes the number and density of the leaflets on the leaf rachis, leaflet length and width, presence or absence of hairs on the upper leaflet surface, length of the inflorescence, density of the flowers and colour of the indumentum on rachides, calyces, bracts and bracteoles. While the presence of short, hyaline or white, patent hairs on the upper leaflet is usually correlated with patent hairs on the pods, and a glabrous upper surface to appressed hairs on the pods, this is not always so (e.g. A.S. *George* 1074 and A.C. *Beauglehole* 1456 both have glabrous upper surfaces to leaflets and patently hairy pods). There is a tendency for narrower leaflets to be glabrous on the upper surface

and for broader leaflets to be patently hairy, but this is not consistent; the trend also appears to be repeated across many species (e.g. *T. sp.* D Kimberley Flora, *T. sp.* Dunes). Variation in the indumentum of the upper leaflet surface is also observable in the Pilbara taxa *T. sp.* NW Eremaean, *T. sp.* clay soils and *T. clementii*. Close examination of the PERTH collection has not identified any other correlations, with both narrow and broad leafleted specimens having a range of indumentum colours (white to ferruginous) on rachides, calyces and pods; all collections have the same indumentum on stems, the same shaped, persistent stipules, and the same calyx and fruit morphology (though fruit length is variable).

The name *T. sp.* Meentheena (S. van Leeuwen 4479) was erected on the WA vascular plant census in July 2003 following survey of the Meentheena Conservation Park by (the then) Department of Conservation and Land Management staff and volunteers as part of a Landscape Expedition in May 2000. A duplicate of the specimen (along with other *Tephrosia* samples) was sent to I. Cowie for identification in February 2002; his response in November 2002 was “4479 *T. sp.* – I need to look into this more – new.” At this stage Cowie’s revisionary work on the WA taxa was in its infancy and, combined with the rather poor quality specimen (stems with few leaves with many of leaflets missing, no mature flowers, fruits insect damaged) and the leaflets being widely spaced, narrow and with glabrous upper surfaces, it is easy to see why this was not identified as the WA-endemic *T. sp.* Fortescue at the time. The name *T. sp.* Meentheena is now considered an informal synonym of *T. sp.* Fortescue.

### ***Tephrosia sp.* G Kimberley Flora (G.J. Keighery 4828)**

*Tephrosia sp.* G, Wheeler, J.R., *Fl. Kimb. Reg.* (1992: 455).

*Tephrosia sp.* Crows foot (I.D. Cowie 8562), Northern Territory Herbarium [name still in use there, see <http://eflora.nt.gov.au/>]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/932726> (CHAH 2011) [accessed 4 May 2017].

*Tephrosia pes-corvus* Cowie ms, de Kok, R.P.J. & Biffin, E., *The Pea Key* (2007); *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/932725> (CHAH 2011) [accessed 4 May 2017].

*Illustration.* Wheeler, J.R. *et al.* (1992). *Fl. Kimb. Reg.* p. 454, Fig 138 B (flowering and fruiting branch, flower).

Erect, perennial *herb* or *shrub*, to 1.5 m tall, width not known. *Branchlets, leaf and inflorescence rachides* with a moderately dense indumentum of broadly and shallowly arched ( $\pm$ strigose) to straight, appressed, white and stramineous hairs, 0.35–0.6 mm long. *Leaves* trifoliolate or pinnate, up to 105 mm long including petiole; *stipules* persistent, antrorse, linear-subulate, 3–7 mm long; *petiole* 3–5 mm long; *ultrajugal rachis* 0–1.5 mm long. *Leaflets* 3–5, very narrowly elliptic, flat in T.S., at least some in the proximal half of the leaf, apices acute, straight; terminal leaflet 65–88 mm long, 5.5–8 mm wide; lateral leaflets 52–80 mm long, 5–7 mm wide; upper surface glabrescent; lower surface sparsely sericeous, hairs appressed, fine, straight, white; secondary veins craspedodromous,

brochidodromous just at apex, in 14–20 pairs, intersecondary veins initially parallel then indistinct. *Inflorescence* fasciculate, axillary, with 2 or 3 flowers in each cluster, showing evidence of probable pseudoraceme formation; *bracts* caducous; *bracteoles* not seen. *Pedice*l 1–3 mm long. *Calyx* 5–7 mm long, shortly sericeous; tube 0.7–75 × the length of lateral lobes; upper lip 2–3.5 mm long, divided to *c.* 70% length; lower and lateral lobes narrowly ovate-triangular, acuminate, the lower lobe distinctly longer than the laterals. *Flowers* orange or yellow-orange, 7–10 mm long; standard claw callused at base, apex broadly and shallowly emarginate; wings much longer than, and overhanging the glabrous keel. *Staminal* tube callused at apex of fenestrae with margins thickened, patently hairy on and in front of callosities; vexillary filament flared outwards near base with prominent ridge-like callosity, patently hairy on and in front of callosity. *Ovules* 8. *Pods* not seen [specimens on loan to DNA], recorded as narrowly oblong, slightly curved, 50–70 × 6–6.5 mm, ±flattened, sericeous, with the margins usually thickened and densely sericeous (Wheeler 1992). *Seeds* not seen [specimens on loan to DNA], recorded as 2–8 per pod, large, with a large, succulent aril (Wheeler 1992).

*Distribution and habitat.* Occurs in WA (NDK) and the NT. Two collections have been made from close proximity on the Mitchell Plateau (WA); however, additional collections have been made from between the Fish River and Western Arnhem Land (NT). Collected from loamy soils in woodland on the Mitchell Plateau and in Nitmiluk National Park, through to rocky dolerite hillslopes and vine thicket on limestone.

*Phenology.* Flowers recorded for February; fruits recorded for April (Wheeler 1992).

*Affinities.* *Tephrosia* sp. G Kimberley Flora is very distinctive in its trifoliolate to closely 5-pinnate leaves, with elongate, very narrowly elliptic leaflets, its very large flowers and in the seed having a large, succulent aril (seen also in *T. oblongata* *vide* Wheeler 1992).

*Notes.* The resemblance of the leaves to the footprints of a bird is reflected in the phrase name in use at DNA and Cowie's manuscript name.

### ***Tephrosia* sp. Kennedy Range (J.S. Beard 4392)**

Erect, moderately open, perennial, semi-woody *shrub*, 0.2–1.5 m tall, 0.4–0.5 m wide. *Branchlets, leaf and inflorescence rachides* very robust, with moderately dense to very dense indumentum of ±patent, ±undulate, uniform or mixed white to golden ferruginous to dark brown hairs, 0.4–1.3 mm long. *Leaves* pinnate, 56–76 mm long including petiole; *stipules* caducous, antrorse, reflexed with age, narrowly lanceolate to deltoid, 2.3–7.4 mm long; *petiole* 0.5–10.7 mm long; *ultrajugal rachis* 0–10.4(–14.1) mm long. *Leaflets* (3–) 5–7, elliptic to obovate, flat in T.S., at least some attached in the proximal half of the leaf, apices obtuse, rounded, truncate or emarginate, straight; terminal leaflet 14.3–47.3 mm long, 8.4–21.2 mm wide; lateral leaflets 18.7–38.3 mm long, 7.9–16.3 mm wide, lateral leaflets increasing in size towards apex, longest adjacent to terminal; upper surface with moderately dense to dense indumentum, hairs ascending to patent, ±undulate, silvery-white to stramineous; lower surface with moderately dense to dense, tomentose

indumentum, hairs ascending to patent, undulate to crisped, silvery-white to stramineous; secondary veins craspedodromous, brochidodromous apically, in (5–)7–12 pairs, intersecondary veins parallel, mid-vein broad, raised, prominent even through indumentum, tertiary veins reticulate, reddish, visible through indumentum because of their colour. *Inflorescence* pseudoracemose, terminal with few axillary fascicles at their base, 21–230 mm long, with 1–3(–4) flowers in each cluster; *bracts* caducous; *bracteoles* absent on pedicels. *Pedicel* 2.3–5.1 mm long. *Calyx* 6.2–9.5 mm long; tube 0.59–0.94 × the length of lateral lobes; upper lip divided to 42–58% length; lower and lateral lobes attenuate to lanceolate. *Flowers* magenta purple, 7–8.2 mm long; standard with bright yellow, stellate ‘eye’ that extends along veins towards margin, linearly callused at base, apex rounded, sometimes emarginate; keel glabrous. *Staminal* tube hairy near fenestrae, the hairs dense on the forward edge of the small, almost rounded, very prominent callosities, extending along open margin of tube; vexillary filament hairy on forward edge of small, almost rounded, prominent callosities, the hairs extending more sparsely beyond this towards anther. *Ovules* 4 or 5. *Pods* linear, tapering into long-acute apex with thickened, elongate beak, strongly upturned at apex, 33.4–50 × 3.1–4.5 mm, compressed; indumentum moderately dense to dense, ascending to patent, stramineous to yellow-brown, apparently dark brown on ovary but becoming paler as fruits develop, sutures very dark; beak in line with upper suture, straight but curving upwards because fruit apex is upturned. *Seeds* 4 or 5 per pod, 6.3–8 mm between centres, not seen mature, shape predicted to be transversely ellipsoid, L:W of immature seeds *c.* 1:1.4, apparently broadly marbled in red-brown and brown, area around hilum yellow-orange to light orange brown, testa texture not known, hilum very slightly excentric; caruncle minute, annular, white-cream. (Figure 24)

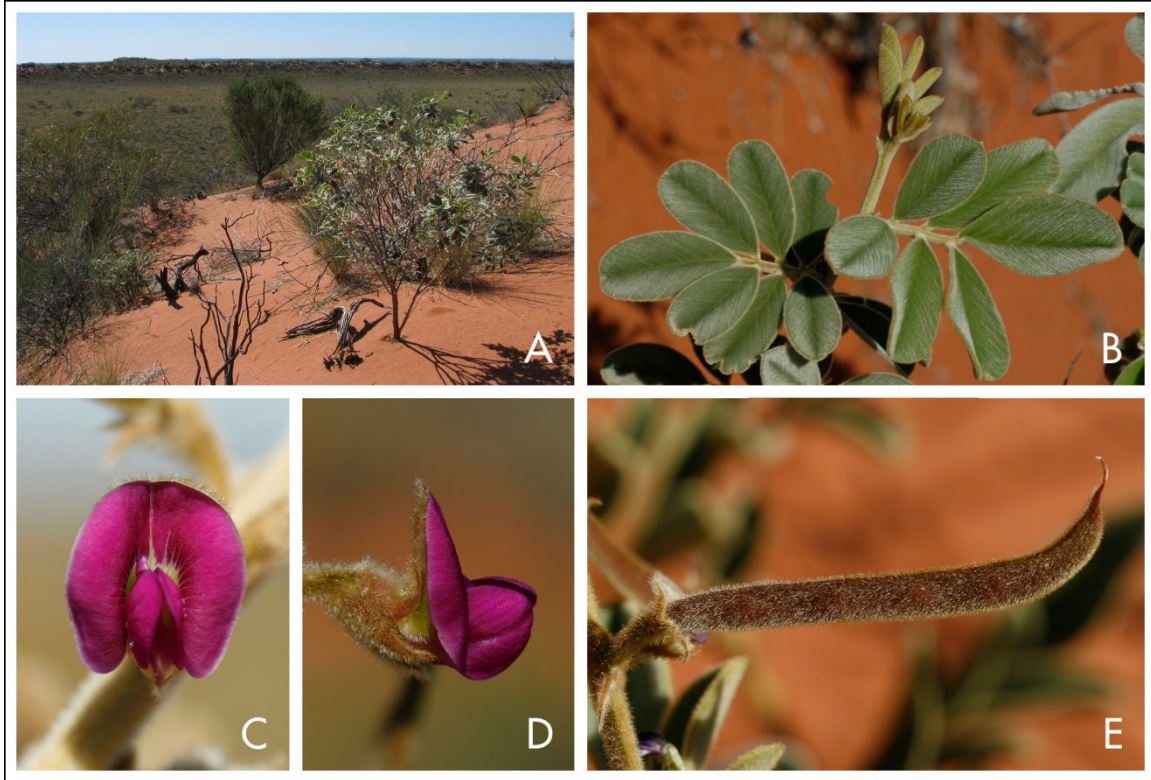
*Distribution and habitat.* Occurs in WA (CAR). To date, known only from the upper slopes of consolidated sand dunes in Kennedy Range National Park, where it grows in open shrubland with *Banksia ashbyi*, *Verticordia forrestii*, *Aluta masonneuvei* and *Crotalaria cunninghamii* over *Ptilotus latifolius*, *P. polystachyus*, *Trichodesma zeylanicum*, *Calothamnus borealis* and species of *Eriachne* and *Aristida*, sometimes with scattered mallee eucalypts.

*Phenology.* Flowers recorded from early August (likely also July; sterile at start of June) and nearly spent by early to mid-September, with fully formed fruit containing immature seed also seen at that time.

*Conservation status.* *Tephrosia* sp. Kennedy Range is listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Smith 2017).

*Affinities.* *Tephrosia* sp. Kennedy Range is part of the *T. rosea* complex, and shares with other members the combination of deep pink-purple flowers with the standard ‘eye’ margin stellate and following the veins for a considerable distance, the staminal tube with pronounced and hairy callosities on the fenestrae, shortly petiolate leaves with *c.* five





**Figure 24.** *Tephrosia* sp. Kennedy Range (J.S. Beard 4392). A – erect, semi-woody shrub with corky base *in situ* on dune crest NE of the Kennedy Range; B – leaves with short petioles, broad leaflets and dense, undulate indumentum; C – flower from front; D – flower from side showing calyx morphology and indumentum; E – immature fruit (4 seed developing) with strongly upturned apex and tardily caducous style. Images from R. Butcher & S. Dillon RB 1538 (A, B), R. Butcher & R. Davis RB 1551 (E) & 1554, (C, D). Photographs by © S. Dillon (A) and R. Butcher (B–E).

leaflets, linear fruit that are upturned at the apex, and seeds that are wider than long with a marbled testa. It can be distinguished from all the other taxa and forms in that group by the dense, velvety indumentum of soft, wavy, silvery to golden brown hairs on stems, leaves, rachides, calyces and fruits. The leaves have very short petioles and short, broad leaflets that are densely hairy on both surfaces. Only *T. rosea* var. Port Hedland comes close to *T. sp.* Kennedy Range in leaf form and indumentum, but is a broad, dull-grey shrub with slender inflorescences and fruits with a less upturned apex.

*Tephrosia* sp. Kununurra also has very shortly petiolate, short, velvety leaves with few leaflets (usually 5–7), but does not have an elongate inflorescence and has much shorter, broadly oblong fruit.

*Notes.* An unidentified specimen collected from sand hills 12 miles N of Lookout Rocks on the No. 1 Rabbit Proof Fence (R.D. Royce 1829a; PERTH 02929317) is very similar to *T. sp.* Kennedy Range in its leaf form (incl. short petiole) and dense, undulate indumentum, but is described on the label as a ‘low branching shrub’ with ‘yellow and brown’ flowers. A collection of *T. sp.* Dunes (R.D. Royce 1829; PERTH 02927489 & 02924242) was made at the same location on the same day and is described as prostrate,



with red-brown or brick red flowers, so the description of *R.D. Royce* 1829a is unlikely to be a transcription error.

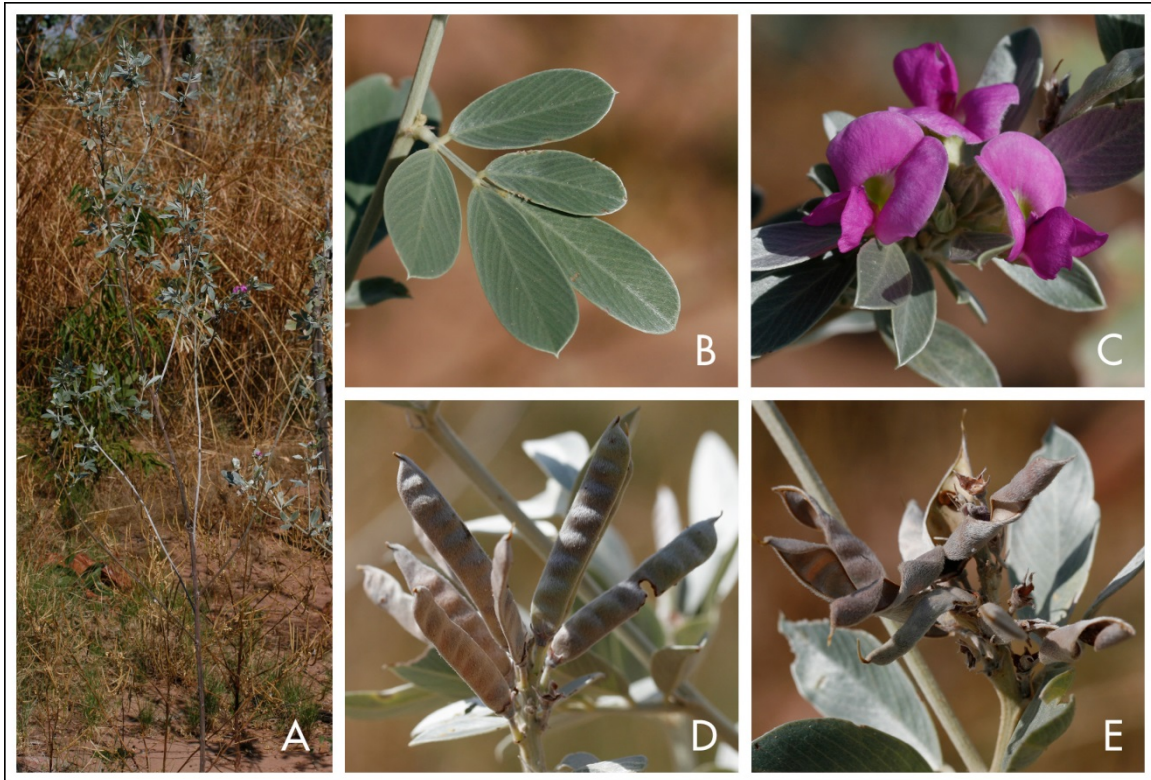
### **Tephrosia sp. Kununurra (T.H. Handasyde TH00 250)**

Erect, slender, narrow, single-stemmed shrub 0.5–2 m tall. *Branchlets, leaf and inflorescence rachides* with dense, silvery to golden, or silvery grey-green indumentum of straight, ascending to patent, white to stramineous hairs, 0.9–1.2 mm long. *Leaves* pinnate, up to 75 mm long including petiole; *stipules* caducous, inclined, red-brown under indumentum, setose, 7–8.3 mm long; *petiole* 3–4 mm long; *ultrajugal rachis* 4.2–6.5 mm long. *Leaflets* (3–)5–9, narrowly elliptic to obovate, flat in T.S., at least some attached in the proximal half of the leaf, apices rounded to truncate to retuse, straight, with a distinct mucro 1.5–2.5 mm long; terminal leaflet 22–47 mm long, 10–20 mm wide; lateral leaflets 20–36.5 mm long, 5.5–9 mm wide, enlarging towards the apex of the leaf; upper surface densely hairy, hairs ascending to patent, straight to slightly wavy, white to stramineous; lower surface as for upper with hairs a little longer; secondary veins craspedodromous, brochidodromous just at apex, in 9–15 pairs, intersecondary veins parallel, difficult to distinguish from secondary veins (so parallel veins appear very numerous) and terminating quite close to the margin, midvein thickened, prominent on lower surface, secondary and intersecondary veins variably cream to red on both surfaces with reticulating tertiary veins also sometimes visible and red. *Inflorescence* a leaf-opposed, contracted pseudoraceme to 45 mm long, with 2–4 flowers in each cluster, axillary clusters of flowers may also be present at base; *bracts* and *bracteoles* setose, caducous. *Pedicele* 2.5–5 mm long. *Calyx* 5.5–6.5 mm long; tube 0.95–1.07 × the length of lateral lobes; upper lip divided to 48.5–75% length; lower and lateral lobes attenuate to narrowly deltoid, lower lobe somewhat narrowly obovate, acuminate. *Flowers* pink to mauve, 9–12 mm long; standard tapering at base into very broadly triangular claw, callused at base, apex broadly emarginate; wings and keel with some long hairs along mid-line and in lower half. *Staminal* tube with short hairs (sometimes dense) on the prominent, rounded callosities positioned at apex of fenestrae, with sparser hairs in front of these; vexillary filament geniculate near base, hairy (sometimes densely) on the prominent, rounded callosities near base, with hairs also behind and in front of these. *Ovules* 6–8, with void at distal end of ovary. *Pods* oblong, straight, 29–40 × 5.5–6 mm, laterally compressed; indumentum moderately dense, fine, patent, white to pale stramineous; beak excentric, straight but angled downwards. *Seeds* 7 or 8 per pod, 3–4 mm between centres, lenticular, sometimes obliquely so, 2.7–3.4 × 2.2–3.2 mm, mid-brown with dark swirls below surface and light pink-tan patches on surface, testa smooth, hilum central; caruncle very small, annular, cream.

*Distribution and habitat.* Occurs in WA (CEK, NOR, VIB) and the NT. Currently known from scattered collections between Theda Station (Mitchell Plateau) southward to Mornington Conservation Sanctuary (WA), eastward to Bullo River Station (NT). Collected from sandstone country associated with gorges and sandy creeklines, in open, *Corymbia* spp. tall woodland.

*Phenology.* Flowers recorded in late February, late April and mid- to late July, and fruits and seeds from February to July.

*Conservation status.* Listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Smith 2017). Recorded as common at one site.



**Figure 25.** *Tephrosia phaeosperma*, showing typical appressed, silvery indumentum covering the plant; *T. sp.* Kununurra has dense, ascending to patent, darker hairs, but leaf, flower and fruit morphology is very similar. A – erect, slender plant from the E Kimberley; B – leaf; C – flowers in contracted inflorescence; D – mature fruits; E – dehiscent fruits. Images from *R. Butcher* RB 1584. Photographs by R. Butcher.

*Affinities.* *Tephrosia sp.* Kununurra is part of the *T. phaeosperma* complex, which also includes *T. sp.* Pentecost River and *T. maculata* Merr. & L.M.Perry (Qld; Papua New Guinea). *Tephrosia phaeosperma* is variable in the size, shape and indumentum density of its leaflets, but is characterised by the combination of pink flowers in contracted pseudoracemes, shortly petiolate leaves with 5–9, prominently veined, elliptic to obovate leaflets with fine, silvery, appressed hairs on the upper and lower surfaces, and  $\pm$ oblong fruits that are laterally compressed but raised over the (3–)4–8, obovoid to lenticular seeds (Figure 25). The *T. phaeosperma* collection at DNA displays more variation than the PERTH collection, and has some hairier specimens; however, none have hairs as dense or dark as *T. sp.* Kununurra.

Superficially similar to *T. stuartii* but this species differs in its shorter stature (to 0.4 m), much smaller leaflets, loose and ascending to  $\pm$ appressed silver-white to yellow-white

indumentum, very short axillary clusters of much smaller flowers (calyx <2.5 mm long) with extremely short pedicels, and short, 2-seeded fruits.

Also superficially similar to *T.* sp. Kennedy Range but this taxon differs in having elongate (to 230 mm), pseudoracemose inflorescences of magenta flowers, and the plant covered in a ferruginous indumentum of wavy to crisped hairs.

### **Tephrosia sp. Magazine Hill (P. Jones 365)**

*Tephrosia* sp. O.T. Station (S.T. Blake 117659), Northern Territory Herbarium [name removed from census]; Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au> [accessed 04 May 2017]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/7255047> (CHAH 2016) [accessed 04 May 2017].

*Tephrosia* 'carpenteriae', in sched. [BRI]

*Tephrosia* 'D53770 OT Station', in sched. [DNA, NT].

Low, spreading *woody herb*, to 0.3 m tall, at least 0.3 m wide, probably annual, with numerous slender stems arising from a narrow rootstock. *Branchlets, leaf and inflorescence rachides* very slender, with sparse to moderately dense indumentum of  $\pm$ patent, straight, white to pale stramineous hairs, 0.4–1.1 mm long. *Leaves* pinnate, up to 49 mm long including petiole; *stipules* persistent, prominent, dark-coloured, recurved, filiform to subulate, 4–7 mm long; *petiole* 1.5–7 mm long, with the first leaves of small, post-fire plants having petioles 20–24 mm long and reducing thereafter; *ultrajugal rachis* 1–7.7 mm long. *Leaflets* 5–11, increasing in size from base to apex of leaf, narrowly elliptic to obovate, flat or V-shaped in T.S., some leaves with all leaflets in the distal half, others with at least some in the proximal half, apices acute to obtuse to retuse, straight to gently recurved, mucro often minute (0.2–0.5 mm long), sometimes to 1.6 mm long; terminal leaflet 4.7–24 mm long, 2.1–8.4 mm wide; lateral leaflets 2.9–16 mm long, 1.4–6.5 mm wide; upper surface with moderately dense, inclined to patent, fine, straight, hyaline hairs (the surface often looking glabrous), sometimes with hairs loosely appressed, white, glabrescent; lower surface indumentum as for upper, except longer and denser; primary and secondary veins on the lower surface thickened, raised, prominent, usually reddish to dark red; secondary veins brochidodromous on larger leaflets, eucamptodromous becoming brochidodromous just at apex on smaller leaflets, in 8–13 pairs, intersecondary veins parallel or obscure. *Inflorescence* pseudoracemose, leaf-opposed at apex of branches, 8–110 mm long, with 1–3 flowers in each cluster; *bracts* persistent, filiform-subulate, 4–7 mm long; *bracteoles* persistent. *Pedicel* 1.5–2.5 mm long. *Calyx* 3.3–4 mm long; tube 0.45–0.62  $\times$  the length of lateral lobes; upper lip divided to 80–87% length; lower and lateral lobes attenuate to setose in appearance. *Flowers* pink-mauve-purple, 3.7–5.5 mm long; standard scarcely linearly callused at base, apex rounded to shallowly emarginate; keel glabrous. *Staminal* tube glabrous, thickened to slightly callused on margins of fenestrae; vexillary filament with scattered hairs from in front of small callosities to *c.* 1/2-way along the filament. *Ovules* 5 or 6 seen, but number higher based on seeds. *Pods* laterally compressed when immature,

almost turgid at maturity but very slightly indented between seeds, prominently upturned at apex (J-shaped) to curved along length, 23–35 × 2.6–3.3 mm; indumentum sparse to moderately dense, the hairs shorter and patent on the darkened sutures, often longer and finer on the faces of the fruits, white; beak long, in line with upper suture, straight. *Seeds* (4–)6–9 per pod, 3.5–4 mm between centres, laterally compressed, transversely obloid-reniform to pulvinate, 1.1–2 × 2.5–3.4 mm, orange-brown to brown, flecked or patterned with darker brown, orange around hilum, testa finely rugose, hilum excentric, positioned c. 1/3 of the way along seed (width-wise); caruncle minute, within the hilar fissure, annular, whitish.

*Distribution and habitat.* Occurs in WA (PIL), the NT and Qld. Known in WA from only two collections to date, but likely to be found further east of existing localities with further surveys, given its widespread distribution in central Australia. In WA, collected from pebbly loam on the crest and slopes of a low rise with scattered *Eucalyptus leucophloia* over low *Acacia* shrubs and *Triodia*, and pebbly sandy loam soils along a drainage line in *Triodia* grassland with open tall *Acacia* shrubs.

*Phenology.* Flowering from March to July and fruiting March to September, with mature seed present on plants collected in May to October.

*Affinities.* *Tephrosia* sp. Magazine Hill is most similar to *T. supina*, *T. stipuligera* and *T. sp.* Willowra; the distinctive features of the latter taxon are discussed under that name.

From *T. supina* it can be readily distinguished by the following characters: more slender stems and inflorescence rachides; paler indumentum; longer, more slender, distinctly inclined to recurved stipules; generally smaller leaflets with a more prominent mucro; the lower leaflet surface with darker red veins which are distinctly thickened and raised; the calyx lobes c. 2–3 × longer than the tube; narrower fruits with a more strongly upturned apex and a (generally) longer beak (often with style ±persistent); laterally compressed, reniform to transversely oblong seeds, which are finely rugose and uniformly red-brown or flecked with dark brown or black.

*Tephrosia* sp. Magazine Hill appears to be closely allied to *T. stipuligera*, which can be distinguished by the following characters: narrowly obovate to spatulate leaflets with prominently recurved apices and longer mucros (0.7–1.2 mm long); eucamptodromous venation with the secondary veins more acutely angled and the intersecondary veins indistinct; shorter, broader (frequently ±oblong) fruit with the apices almost straight to only slightly upturned; smooth, ellipsoid seeds that are not compressed and are mottled shades of brown to mottled dark purple-brown.

*Notes.* Possible annual or short-lived disturbance opportunist. Noted to be abundant on recently burnt rocky slope (*D. Albrecht* 7649 & *P. Latz*), with collections of extremely young plants, complete with tap-root, from that habitat already with mature fruit and seed (*D. Albrecht* 7646 & *P. Latz*).

### **Tephrosia sp. Mistake Creek (A.C. Beaglehole 54424)**

Slender, open, erect *shrub*, *c.* 1.5–3 m tall, to 1 m wide; upper branchlets ribbed. *Branchlets, leaf and inflorescence rachides* sericeous with dense, fine, straight, appressed, silvery white to light golden indumentum, hairs 0.2–0.4 mm long. *Leaves* pinnate, 25–54 mm long including petiole; *stipules* persistent, antrorse then slightly inclined, becoming curved with age, narrowly deltoid, 4–5.7 mm long; *petiole* 1.5–4 mm long; *ultrajugal rachis* 1.3–3.1 mm long; petiole and rachis strongly channelled. *Leaflets* (3–)5(–7), oblong-obovate to obovate, flat in T.S., at least some in the proximal half of the leaf, apices rounded to retuse, straight, with a mucro 0.4–0.6 mm long; terminal leaflet 21–40 mm long, 9.5–17 mm wide; lateral leaflets 20–35 mm long, 6.8–13.5 mm wide; upper surface sericeous, hairs appressed, fine, straight, silvery white to greenish pale gold; lower surface indumentum as for upper; secondary veins craspedodromous, in 10–13 pairs, intersecondary veins apparently parallel, obscured by dense, appressed indumentum, mid-vein thick on lower surface, secondary and tertiary veins reddish on upper surface (when visible). *Inflorescence* a contracted pseudoraceme, on short lateral branches, often appearing terminal, 6–30 mm long, with 3 or 4 flowers in each cluster; *bracts* and *bracteoles* ovate, acute, caducous. *Pedicel* 1–3.5 mm long. *Calyx* 4.5–5 mm long; tube 0.74–1.05 × the length of lateral lobes; upper lip divided to 35–50% length; lower and lateral lobes attenuate. *Flowers* pink, 6.5–11 mm long; standard callused at base, apex emarginate; keel glabrous or with a few hairs along the lower margin. *Staminal* tube hairy on and in front of callosities, these positioned at the apex of the fenestrae; vexillary filament hairy on callosities with hairs extending along filament for up to 1/3 length, the callosities small but prominent, near base. *Ovules* 7–10. *Pods* linear, continuously curved along length with apex distinctly upturned, 55–60 × *c.* 4 mm, laterally compressed; indumentum moderately dense, hairs appressed to loosely appressed, white; beak in line with upper suture, straight. *Seeds* 7–10 per pod, 4–6 mm between centres, laterally compressed, transversely oblong, *c.* 2.2 × 4.1–4.4 mm, light brown with dark brown flecks to dark brown, orange-brown around hilum, smooth, hilum central; caruncle small, annular, white. (Figure 26)

*Distribution and habitat.* Occurs in WA (border of DAL & CEK, VIB, OVP) and the NT. Mostly distributed from north of Lake Argyle (WA) south-eastward to the Tanami mine (NT), with disjunct western collections at Windjana Gorge, Napier Range (WA). Collected from alluvial flats and in rocky stream beds; recorded as occurring in woodland of *Gyrocarpus*, *Terminalia* and *Bauhinia*.

*Phenology.* Flowers recorded in February, March and November; fruits recorded in February, March, July and November.

*Conservation status.* Listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Smith 2017).

*Affinities.* *Tephrosia* sp. Mistake Creek is part of the *T. rosea* complex, which contains a number of putatively new taxa and a larger number of forms that cannot yet be adequately placed.





**Figure 26.** *Tephrosia* sp. Mistake Creek (A.C. Beaglehole 54424). A – narrow, slender shrub in creekline habitat; B – leaf showing extremely short petiole; C – flower in contracted inflorescence; D – insect-damaged, long, narrow fruit in contracted infructescence. Images from *H. Dauncey* H 411. Photographs © H. Dauncey, used with permission.

This taxon corresponds to the ‘short inflorescence’ form of *T. rosea*; the voucher for the phrase name is held at DNA (dup. at MEL) and the name was first used in a checklist of vascular plants occurring in the NT (Cowie & Albrecht 2005) before being placed on the NT plant census (see Short *et al.* 2011). Although quite distinctive, this taxon requires further research to assess its status (and rank) relative to other forms in the Kimberley and NT (e.g. *T. rosea* ‘Kimberley sericeous form’, a much lower shrub with smaller leaflets and elongate inflorescences, also with sericeous leaves and stems and long, curved fruit, plus PERTH specimens currently identified as *T. rosea* subsp. *rosea*, having reasonably short inflorescences with long, curved fruit, but discoloured leaflets with loose, inclined indumentum).

In general, *T. sp.* Mistake Creek can be distinguished by the following combination of characters: tall, slender stature; extremely short petioles and usually 5, moderately large, obovate leaflets with appressed silvery indumentum on both surfaces; large, pink flowers in contracted, apparently terminal inflorescences; long, narrow fruits that are curved along their length, with loosely appressed indumentum; 7–10 ovules and seeds.

*Tephrosia sp.* Mistake Creek is similar to *T. phaeosperma* in having shortly petiolate leaves, leaflets with appressed-silvery hairs, contracted inflorescences, and pink flowers with prominent and hairy callosities on the staminal tube and vexillary filament. It can be



readily distinguished from that species by its fruits, which are long, linear and upwardly curved, and contain 7–10 transversely oblong seeds.

### **Tephrosia sp. Newman (A.A. Mitchell PRP 29)**

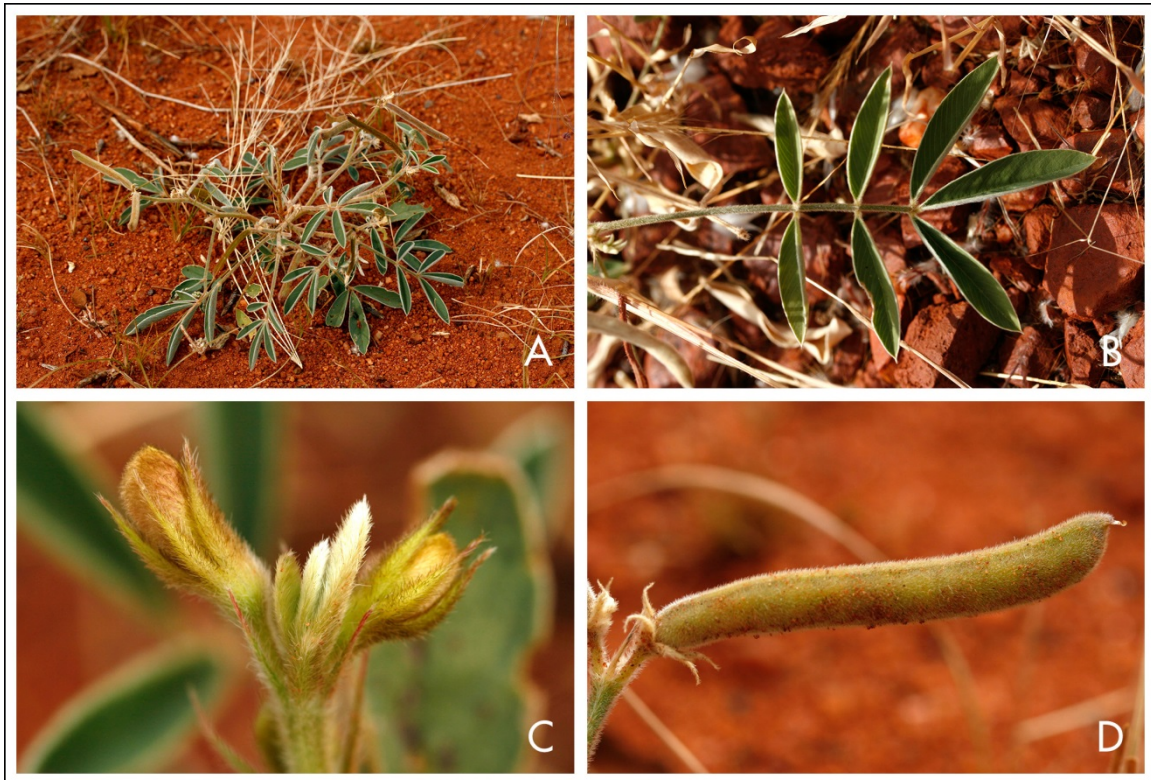
'*Tephrosia* aff. *clementii* (2)', Trudgen, M.E. & Casson, N., *Flora and vegetation surveys of Orebody A and Orebody B in the West Angela Hill area...* (1998).

Prostrate to spreading, perennial, woody *herb* to small *subshrub* 0.1–0.4 m tall, to 0.5 m wide. *Branchlets, leaf and inflorescence rachides* with an indumentum of moderately dense to dense, straight, loosely appressed to strongly inclined, white to stramineous hairs, 0.8–1.3 mm long. *Leaves* pinnate (rarely palmate and then at the base of branches), up to 150 mm long including petiole, which is frequently deflexed at pulvinus; *stipules* persistent, antrorse, linear-subulate to narrowly triangular, 5.5–10.5 mm long; *petiole* 16.5–70 mm long; *ultrajugal rachis* usually absent, rarely to 3.6 mm long. *Leaflets* (3–) 5–7, narrowly to broadly elliptical, occasionally oblanceolate, gently keeled in T.S., all in the distal half of the leaf, apices acute to obtuse, straight; terminal leaflet 25–55 mm long, 7–15 mm wide; lateral leaflets 17–43 mm long, 5.5–14 mm wide; upper surface dull light green, sometimes purplish, glabrous; lower surface grey-green, indumentum moderately dense to dense, hairs loosely appressed to inclined, straight, white, protruding beyond leaflet margin to form a distinct white border to leaflet when viewed from above; secondary veins craspedodromous, brochidodromous toward apex, in 11–18 pairs, intersecondary veins parallel at base then indistinct, generally obscure on the lower surface, parallel secondary venation visible on lower surface through indumentum. *Inflorescence* pseudoracemose, leaf-opposed, 20–95(–200) mm long, with 3–5 flowers in each cluster, axillary fascicles also present at the base; *bracts* persistent; *bracteoles* absent. *Pedicel* 2–3.8 mm long. *Calyx* 5.7–7.5 mm long; tube 0.33–0.55 × the length of lateral lobes; upper lip divided to 50–87% length; lower and lateral lobes lanceolate. *Flowers* pale orange, 5–7.5 mm long; standard not callused at base, apex emarginate; keel with a few hairs along the lower edge towards apex. *Staminal tube* glabrous, not callused; vexillary filament glabrous, not callused. *Ovules* 8–12. *Pods* linear, ±straight, slightly upturned at apex, 26–47 × 2.7–5 mm, turgid; indumentum moderately dense, inclined to patent, sometimes loosely appressed, white, stramineous or rufous; beak in line with the upper suture, straight or straight then shortly downcurved. *Seeds* 9–12 per pod, 3.5–4.5 mm between centres, ±spherical to cuboid-pulvinate to (infrequently) transversely obloid-ellipsoid, 2.2–2.7 × 2.6–3.5 mm, uniformly orange/red-brown or lighter and darker orange-brown, frequently flecked with dark brown or black, testa rugose, hilum central; caruncle minute in hilar fissure, circular, white. (Figure 27)

*Distribution and habitat.* Occurs in WA (PIL, GAS, GSD, LSD). Occurs in open mulga scrub, open tall shrubland and tussock grassland, in sandy loam and sandy clay loam soils, frequently in association with creeklines and alluvial flood plains, or on low, gravelly rises.

*Phenology.* Flowers observed March to July, fruits and seed April to September. Most collections (with fruits and seeds in high number) made in May.

*Affinities.* Specimens of *T. sp.* Newman were originally identified variously as *T. sphaerospora*, *T. supina* [auct. non Domin] *T. aff. clementii*, *T. aff. clementii* (2) [Trudgen & Casson 1998], *T. aff. supina*, *T. aff. sphaerospora*, *Tephrosia sp.* and even *T. rosea*. Of these it bears greatest resemblance to *T. sphaerospora* and *T. clementii*, with other similar taxa being *T. sp. deserts* and *T. sp. NW Eremaean*. With all four it shares its prostrate to spreading habit, pale orange flowers and linear, turgid fruits with patent indumentum. From *T. clementii* it can be distinguished by its pinnate leaves, gently upturned fruit apex and distinctly rugose seeds (vs palmate; straight; smooth to broadly dimpled), from *T. sphaerospora* by its glabrous upper leaflet surfaces, absent or minute ultrajugal rachis, and orange-brown, flecked, rugose seeds (vs finely and sparsely appressed- to patent-hairy; ultrajugal rachis distinct; boldly mottled and smooth). From *T. sp. deserts* it can be distinguished by its low, mounded habit, longer (0.8–1.3 mm), darker and inclined indumentum, 5–7 leaflets, larger calyx and gently upturned fruit apex (vs mat-forming; shorter (0.3–0.9 mm), white and appressed; 3–5 leaflets; calyx 4.4–5.9 mm long; straight), and from *T. sp. NW Eremaean* by its narrowly elliptic to elliptic leaflets with subtly raised, parallel venation on the lower leaflet surfaces, and spherical to cuboid-pulvinate, orange-brown, flecked, rugose seeds (vs obovate to rhombic; pronounced, more reticulating venation; transversely ellipsoid, finely mottled, smooth to broadly dimpled) (see Table 5).



**Figure 27.** *Tephrosia sp.* Newman (A.A. Mitchell PRP 29). A – spreading plant *in situ*; note the deflexed leaves with very long petioles; B – pinnate leaf with narrowly elliptic, gently keeled leaflets with glabrous upper surfaces; C – scarcely opening flowers showing deeply divided calyx; D – turgid, linear fruit with slightly upturned apex and patent indumentum. Images from R. Butcher & S. Dillon RB 1492 (B) & 1505 (A, C, D). Photographs by R. Butcher.

It shares its habit and brown, rugose seeds with *T. sp.* clay soils, but that can be distinguished by its palmate leaves, shorter calyx lobes, slightly laterally compressed fruits with a more raised apex and appressed indumentum; seeds tend to be broader also.

### **Tephrosia sp. North West Cape (G. Marsh 81)**

Small, spreading *shrub*, *c.* 0.2 m tall × 0.7 m wide. *Branchlets, leaf and inflorescence rachides* with moderately dense, straight, ascending to patent, white, indumentum, 0.45–0.9 mm long. *Leaves* palmate to pinnate (rare), frequently sub-pinnate with the lowermost two pairs of leaflets arising at the same point and separated from the uppermost pair by an intrajugal rachis 1.5–7.3 mm long, up to 78 mm long including petiole; *stipules* persistent, antrorse, attenuate to narrowly lanceolate, 4.6–7.2 mm long; *petiole* 25–47 mm long; *ultrajugal rachis* absent. *Leaflets* 5–7(–9), narrowly obcuneate to narrowly obovate, broadly V-shaped in T.S., all attached in distal half of leaf, apices truncate to retuse with minute mucro 0.4–0.5 mm long, ±straight; terminal leaflet 12–25 mm long, 4.2–6.7 mm wide; lateral leaflets 7.2–21 mm long, 3.2–6.7 mm wide; upper surface with moderately dense indumentum, hairs loosely appressed, straight, white; lower surface with moderately dense to dense indumentum, hairs loosely appressed, straight, silvery white, hyaline; secondary veins obscure on lower surface of leaflets, 7 pairs visible on one specimen, intersecondary veins obscured by indumentum on lower leaflet surface, mid-vein raised on lower surface of leaflets. *Inflorescence* pseudoracemose, leaf-opposed, 4–20 mm long, with 2 flowers in each cluster; *bracts* persistent; *bracteoles* absent. *Pedicel* 2.1–2.5 mm long. *Calyx* 5.5–7 mm long; tube 0.65–0.85 × the length of lateral lobes; upper lip divided to 55–65% length; lower and lateral lobes narrowly triangular to lanceolate. *Flowers* orange, 6–6.5 mm long; standard not callused at base, apex truncate to very shallowly and broadly emarginate; keel with a few hairs scattered along lower margin. *Staminal* tube glabrous near fenestrae, which are not callused on margins; vexillary filament glabrous, not callused. *Ovules* 8 or 9. *Pods* linear, straight, 22–36 × 3.2–4.4 mm, raised above seeds to turgid; indumentum moderately dense, inclined to patent, white and stramineous; beak somewhat excentric, downcurved. *Seeds* 6–9 per pod, *c.* 4 mm between centres, obliquely ellipsoid, slightly laterally compressed, 2–4.8 × 2.3–6 mm, bi-coloured, light orange-brown with dark brown to black flecks and streaks, testa smooth, hilum slightly off-centre; caruncle minute within hilum, annular, transparent to white. (Figure 28)

*Distribution and habitat.* Occurs in WA (CAR). On current knowledge, known only from two locations on North West Cape, where it has been collected from orange-red to brown soil with limestone fragments, over limestone, growing with *Triodia*, *Acacia* and *Ipomea*. Further field work is required to determine its range.

*Phenology.* Flowers and fruits observed in May and July.

*Conservation status.* *Tephrosia sp.* North West Cape (G. Marsh 81) is listed at Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian



Flora (Smith 2017). One of the two known specimens is from Cape Range National Park on the west side of the Cape, the other is from an unreserved site on the east side of the Cape, c. 6 km S of Exmouth. Its abundance at each site is not known.



**Figure 28.** *Tephrosia* sp. North West Cape (G. Marsh 81). A – semi-prostrate plant showing mix of palmate and sub-pinnate leaves (see description above); B – developing sub-pinnate leaf showing overlapping leaflets that have not yet separated with an intrajugal rachis; note retuse leaflet apices and indumentum; C – scarcely opening flower showing calyx morphology and indumentum. Images from *D. Sandow s.n.* (PERTH 08729344) (A, B) and *T. Thomson* DSA/6/16 (C). Photographs © T. Thomson, used with permission.

*Affinities.* The name *T. sp.* North West Cape has only recently been placed on WA vascular plant census, following the collection of a second specimen matching one (*G. Marsh* 81) filed under *T. aff. clementii* at PERTH; it is part of the *T. clementii* complex.

*Tephrosia* sp. North West Cape is similar to *T. clementii*, *T. sp.* clay soils and *T. sp.* deserts in being a low, semi-prostrate woody herb with palmate leaves and pale orange flowers. It is distinguished from all these by the following combination of characters: coarser stems and rachides; dense, short, patent indumentum on stems and rachides; leaves a mixture of palmate and sub-pinnate; leaflets narrowly obovate to narrowly obcuneate, apices truncate to retuse; dense, loosely appressed hairs on the leaflet lower surface and moderately dense, loosely appressed hairs on the upper surface.

The geographically closest specimen of *T. clementii* at PERTH (*S. van Leeuwen et al.* PBS 0276; 3.9 km N of Onslow turnoff on North West Coastal Hwy) is a good example

of that species as defined by the type. *Tephrosia rosea* var. *clementii* is the only other *Tephrosia* known from North West Cape.

*Notes.* Field observations indicate that *T. sp.* North West Cape is perennial, if only short-lived, with plants persisting from one year to another. It also grows rapidly from seed, with large, juvenile plants evident in the following year. The absence of specific plants from one year to the next may also be attributable to grazing by rabbits and goats, both of which are active at the known populations (T. Thomson, pers. comm.).

### **Tephrosia sp. Northern (K.F. Kenneally 11950)**

*Tephrosia supina* auct. Wheeler, J.R., *Fl. Kimb. Reg.* (1992: 441); auct. G. Paczkowska & A.R. Chapman, *W. Austral. Flora: Descr. Cat.* (2000: 451), *p.p.*, collections from CK, DL, OVP, TAN, VB.

Semi-prostrate to low-growing *subshrubs* with spreading stems, 0.1–0.5 m tall, 0.1–0.35 m wide. *Branchlets, leaf and inflorescence rachides* with moderately dense, straight, patent to somewhat ascending, white to stramineous indumentum of mixed length hairs, 0.4–1.1 mm long. *Leaves* pinnate, up to 90 mm long including petiole; *stipules* persistent, antrorse then divergent, attenuate, 5.2–7.5 mm long; *petiole* 11–17.5 mm long; *ultrajugal rachis* 0–7.2 mm long. *Leaflets* (5–)7–11, narrowly obovate, almost oblong or elliptic, to obovate, flat to more usually V-shaped in T.S., at least some in the proximal half of the leaf, apices rounded, straight; terminal leaflet 12–30 mm long, 6.4–17 mm wide; lateral leaflets 6.8–26 mm long, 4.5–12.5 mm wide; upper surface light green, with a sparse to moderately dense indumentum of appressed, straight, hyaline hairs; lower surface grey-green, with a longer, denser indumentum of spreading to inclined, straight, white to pale stramineous hairs; secondary veins eucamptodromous at base then subtly brochidodromous towards the apex, in (6–)8–10(–12) pairs, intersecondary veins obscure, midvein and secondary veins slightly raised to raised on the lower surface and usually indistinct to slightly sunken on the upper surface. *Inflorescence* shortly pseudoracemose, leaf-opposed, usually with an axillary cluster of flowers at its base, to 90 mm long, with 1–3(–4 in axils) flowers in each cluster; *bracts* persistent; *bracteoles* deciduous. *Pedicel* 1.5–2.8 mm long. *Calyx* 5.2–7 mm long; tube 0.3–0.4 × the length of lateral lobes; upper lip divided to 64–94% length; lower and lateral lobes long-attenuate to setose, with lower lobe longer than laterals. *Flowers* orange, *c.* 5.5–7.3 mm long; standard scarcely callused at base, apex retuse; keel usually glabrous. *Staminal* tube glabrous, not callused; vexillary filament glabrous, not callused. *Ovules* (3–[odd])9 or 10. *Pods* linear, almost straight to upcurved at apex, 34–42 × 3.7–4 mm, turgid; indumentum moderately dense to dense, patent, white; beak in line with upper suture, ±straight to inclined. *Seeds* (6–)8–10 per pod, 3.5–4 mm between centres, sub-globose to transversely ellipsoid, 1.95–2.9 × 2.6–3.3 mm, variably mottled, sometimes finely, in pink-tan, light brown, orange-brown, dark brown and black, testa smooth to broadly dimpled, hilum central; caruncle (?) a minute annular structure within the hilum. (Figure 29)

*Distribution and habitat.* Occurs in WA (DAL, OVP, CEK, VIB, with limited extension into GSD & TAN, and outliers in PIL), the NT and Qld. Habitat variable, but commonly collected from red sandy loams and sandy clays on plains with very open tall shrubland

or low woodland in grassland, and also from sandy areas associated with calcrete or basalt laterite bedrock. In the E Kimberley, often collected from disturbed sites.

*Phenology.* Collected in flower from February to May, and August; fruits collected February to May.



**Figure 29.** *Tephrosia* sp. Northern (K.F. Kenneally 11950). A – spreading plant *in situ*; B – leaf, from above; C – lower surface of leaflets; D – side view of flower showing calyx morphology; E – immature, turgid fruit with slightly upturned apex and straight beak. Images from H. Dauncey H 387 (A) & H 443 (B–E). Photographs © H. Dauncey, used with permission.

*Affinities.* *Tephrosia* sp. Northern is part of a complex that includes *T.* sp. NW Eremaean and *T.* sp. central; it is the most problematic of the three taxa and the most difficult to define adequately, having characters of both of these. It is more similar to *T.* sp. NW Eremaean in leaflet shape, number of secondary veins, calyx morphology (i.e. long, slender lobes that are longer than the tube), and fruit shape, but the pattern of venation is not prominently brochidodromous and the intersecondary veins are obscure. Removing hairs from the leaflet surfaces to better see venation suggests they may be weakly brochidodromous, but this is difficult to interpret accurately. The higher number of leaflets distinguishes it from *T.* sp. NW Eremaean also. Outlying collections from the Jigalong area are quite soft-textured and are clearly different from *T.* sp. NW Eremaean despite occurring in approximately the same area, suggesting a genetic rather than environmental basis for the morphological differences.



Usually readily distinguishable from *T. sp.* Central by its leaflet shape and calyx morphology, but sterile specimens can be hard to place because of similarities in indumentum, leaflet number and the eucamptodromous venation.

Similar to *T. sp.* Yampi in the shape and number of leaflets, but that taxon has much more recurved, leaf-like stipules, smaller flowers with calyx tube *c.* equal in length to the lobes, laterally compressed fruits that are flattened between the seeds and have a slightly sinuous margin, and lenticular seeds with long funicles.

### **Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)**

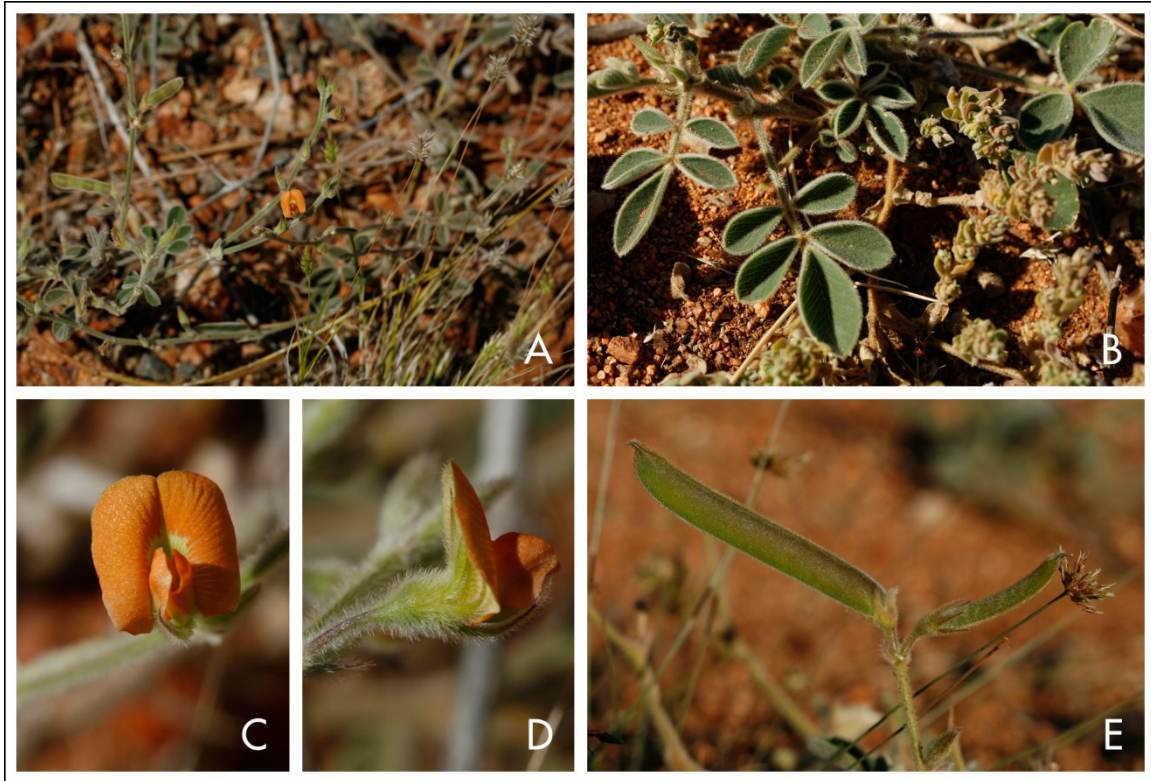
*Tephrosia supina* auct. G. Paczkowska & A.R. Chapman, *W. Austral. Flora: Descr. Cat.* (2000: 451), *p.p.*, collections from MUR, PIL.

Low-growing *subshrubs* with spreading stems, to 0.35 m tall, 0.3 m wide. *Branchlets, leaf and inflorescence rachides* with a moderately dense to dense indumentum of straight, patent, white (hyaline) to stramineous hairs, 0.2–1.1 mm long. *Leaves* pinnate, (33–)54–151 mm long including petiole; *stipules* persistent, antrorse to divergent, shape, 3.5–13 mm long; *petiole* 5–52 mm long; *ultrajugal rachis* 0–10 mm long, usually absent. *Leaflets* (3–)5–7, rhombic to narrowly through broadly obovate, flat or V-shaped in T.S., usually all attached in the distal half of the leaf, apices rounded or obtuse to acute, with a short to prominent mucro, erect; terminal leaflet 14–42 mm long, 7–24 mm wide; lateral leaflets 7–27 mm long, 4–18 mm wide, noticeably grading in size from smallest at base to largest at apex; upper surface pale green, glabrous or with inclined to patent, moderately long, white to stramineous hairs; lower surface greyish green with moderately long to long, ascending, white to stramineous hairs; secondary veins raised on the lower surface and anastomosing before margin, prominently brochidodromous, in (5–)6–12 (–16) pairs, intersecondary veins prominent, reticulating, veins cream. *Inflorescence* pseudoracemose, leaf-opposed towards end of branches, 28–254 mm long, with 1 or 2 (–3) flowers in each cluster; *bracts* persistent; *bracteoles* absent. *Pedicel* (0.8–)1.3–5 mm long. *Calyx* 4–8.4 mm long; tube (0.32–)0.45–0.8 × the length of lateral lobes; upper lip deeply divided to (65–)71–98% length; lower and lateral lobes attenuate. *Flowers* orange, 4.5–7.5 mm long; standard callused at base, apex retuse; keel usually glabrous, rarely with a couple of hairs on lower margin near apex. *Staminal* tube glabrous, not callused, margins of fenestrae slightly thickened; vexillary filament glabrous, not callused. *Ovules* 8–12. *Pods* linear, straight, 24–45 × 3–4.5 mm, turgid; indumentum moderately dense to dense, patent to inclined, white (hyaline) to stramineous; beak in line with the upper suture and straight. *Seeds* (3–)7–11 per pod, 3–4 mm between adjacent centres, obovoid to sub-globose, 1.5–2.9 × (1.4–)1.7–3.1 mm, predominantly tan and orange- to red-brown with smaller areas of black, distinctly orange around hilum, testa smooth through broadly dimpled to irregularly rugose, hilum central; caruncle (?), a minute, annual structure present in hilar fissure. (Figure 30)

*Distribution and habitat.* Occurs in WA (PIL, GAS). Widespread across the Pilbara with scattered collections in the NW Gascoyne. Collected from pink-red to red-brown, shallow, sandy clays and loams, on and at the base of steep to gentle rocky slopes, and on

usually stony outwash plains. Associated vegetation includes spinifex grassland, open tall shrubland (commonly *Acacia* spp.) with open low shrubs and grasses, sometimes also with scattered to open *Eucalyptus* spp. and *Corymbia* spp.

*Phenology.* Flowers recorded February to May and August; fruiting from February with mature fruits recorded March–May and August, and seeds in April–May and August–September.



**Figure 30.** *Tephrosia* sp. NW Eremaean (S. van Leeuwen et al. PBS 0356). A – prostrate plant; B – leaves; C – flower from front; D – flower from side showing calyx morphology and indumentum; E – immature, straight, turgid fruit with beak in line with the upper suture. Images from R. Butcher & R. Davis RB 1555 (A, C, D) and R. Butcher & S. Dillon RB 1515 (B, E). Photographs by R. Butcher.

*Affinities.* *Tephrosia* sp. NW Eremaean is part of a complex that includes *T.* sp. Northern and *T.* sp. central; it is the least problematic of the three taxa and the most readily distinguishable, despite displaying variation in leaflet shape and indumentum. Key characters for its differentiation from these taxa as well as from *T.* sp. Newman are its rhombic to narrowly through broadly obovate leaflets, which grade noticeably from smallest pair at the base to largest pair subtending the even-larger terminal leaflet, and its prominently brochidodromous venation, with prominent, reticulating intersecondary veins. With *T.* sp. Newman and *T.* sp. Northern it shares long, slender calyx lobes that are at least twice as long as the calyx tube (in *T.* sp. central the tube and lobes are *c.* the same length or the lobes are less than twice the length of the tube). Plants of *T.* sp. NW Eremaean can have either a patently hairy or glabrous surface to the upper leaflets, while those of *T.* sp. Newman are always glabrous, with the lower surface finely appressed-

hairy; when glabrous in *T. sp.* NW Eremaean, this taxon can be distinguished by the venation on the lower surface (parallel in *T. sp.* Newman), its straight fruits with a straight beak (upturned with a beak that is straight then downcurved in *T. sp.* Newman) and its smooth to dimpled seed (rugose in *T. sp.* Newman). Differences from *T. oxalidea* are discussed in Butcher and Hurter (2012), and differences from *T. sp.* Central are discussed under that taxon.

### **Tephrosia sp. Pentecost River (I.D. Cowie 4168)**

*Tephrosia phaeosperma* var. Westmoreland (S. Melville 967), Queensland Herbarium; Holland, A.E. & Pedley, L., *Census of the Queensland Flora* (2010: 78) [name still in use there]; *Australian Plant Census*, <https://biodiversity.org.au/nsl/services/instance/apni/7258634> (CHAH 2016) [accessed 4 May 2017].

*Tephrosia phaeosperma* var. 'minor', in sched. [BRI]

*Tephrosia laxa* Domin *auct. non* Wheeler (1992) (= *T. sp.* Pentecost River).

*Illustration.* Wheeler, J.R. *et al.* (1992). *Fl. Kimb. Reg.* p. 444, Fig 134 B (flowering branch, flower), as *T. laxa*.

Erect, compact, *shrub*, 0.3–1 m tall, 0.3–0.5 m wide, often with a greenish gold aspect. *Branchlets, leaf and inflorescence rachides* with a sericeous indumentum of moderately dense to dense, fine, straight, appressed, white to stramineous, gold or grey-green hairs, 0.3–0.5 mm long. *Leaves* pinnate, up to 80 mm long including petiole; *stipules* persistent, antrorse to recurved with age, subulate to narrowly deltoid, 2.3–5 mm long; *petiole* 2.5–7 mm long; *ultrajugal rachis* 0–3.1 mm long. *Leaflets* (1–)3–7(–11), narrowly oblong-obovate to narrowly elliptic-obovate or narrowly elliptic, flat in T.S., at least some attached in proximal half of leaf, apices obtuse to rounded, with a short but distinct mucro 0.5–0.8 mm long, straight to slightly recurved; terminal leaflet 25–45 mm long, 4–10 mm wide; lateral leaflets 10–35 mm long, 3–7 mm wide; upper surface sparsely to moderately densely sericeous, occasionally glabrous, hairs appressed, fine, straight, white to stramineous lower surface sparsely to moderately densely sericeous, hairs appressed, fine, straight, white to stramineous, a little longer than the upper surface; secondary veins craspedodromous, in 6–10 pairs, intersecondary veins parallel, becoming diffuse before margins, veins (including tertiary) often red, this most pronounced on the upper surface. *Inflorescence* pseudoracemose, rachis often angular, leaf-opposed, 55–140 mm long, with 2 or 3 flowers in each cluster, some axillary flowers also at base; *bracts* triangular, persistent; *bracteoles* not seen. *Pedicel* 0.8–2 mm long. *Calyx* 2.5–4 mm long, sericeous; tube 0.69–0.81 × the length of lateral lobes; upper lip divided to 50–60% length; lower and lateral lobes narrowly triangular. *Flowers* pink to mauve or violet, 4.5–6.5 mm long; standard callused at base, apex broadly emarginate; keel glabrous. *Staminal* tube with hairs on prominent, small, rounded callosities and along margin of fenestrae in front of callosities; vexillary filament with hairs on prominent, small, rounded callosities near base. *Ovules* 6 or 7. *Pods* oblong, straight, 16–25 × 4–5.3 mm, laterally compressed; indumentum sparse to moderately dense, hairs appressed, inclined or patent, white; beak in line with upper suture or excentric, straight to angled downwards, style tardily



caducous. *Seeds* 3–6 per pod, 3.2–3.7 mm between centres,  $\pm$ lenticular to compressed-orbicular, often oblique or elongated, 2.35–2.7  $\times$  2.5–3.1 mm, mid-brown with pinkish blotches or also with back blotches, the hilum surrounded by an orange-brown ring, testa smooth, hilum  $\pm$ central to excentric, seeds obliquely angled within pods; caruncle small, annular, opaque to white. (Figure 31)



**Figure 31.** *Tephrosia* sp. Pentecost River (I.D. Cowie 4168). A – fruiting shrub among sandstone rocks above waterhole; B – leaves showing greenish gold aspect to vegetative branches; C – flowers; D – immature fruits; E – mature fruits. Images from R. Butcher & A.N. Start RB 1870 (A, B, D, E) and B.J. Carter 394 (C). Photographs by R. Butcher (A, B, D, E) & © B.J. Carter (C), used with permission.

*Distribution and habitat.* Occurs in WA (DAL, NOK, CEK, VIB, OVP), the NT and Qld. Apparently widespread through the Kimberley in open woodland and shrubland, but collections mostly corresponding to roadsides and areas accessible by road; overlaps with *T. phaeosperma* across its range. Collected from a variety of habitats including coastal dunes with *Spinifex*, coastal vine thickets, sandy-clay plains and dry creek beds, but most commonly found on slopes among sandstone or basalt rocks, frequently above or adjacent to creeklines or waterholes.

*Phenology.* Flowering predominantly February to May; fruiting predominantly March to May, with seeds from April to July.

*Affinities.* *Tephrosia* sp. Pentecost River was recognised as distinct by I. Cowie (DNA). It superficially resembles *T. laxa* and that name was misapplied to specimens of *T. sp.* Pentecost River by Wheeler (1992), based on numerous misidentified specimens at

PERTH. Plants with widely spaced, narrowly elliptic leaflets do look like *T. laxa* var. *angustata*, but that taxon has much larger leaflets and linear fruits with an upturned apex (flowers not seen).

In its pink to mauve flowers, oblong fruits, ±lenticular, mottled seeds, and leaves with mostly 5–7 leaflets, *T. sp.* Pentecost River is similar to *T. phaeosperma*. It can be readily distinguished by its greenish gold (vs silver) aspect, its smaller, more sparsely hairy leaflets, its slender, elongate inflorescences, its smaller flowers (4.5–6.5 mm long) with glabrous petals, and its smaller fruit with fewer seeds.

**Tephrosia sp. Saw Ranges (D. Kabay s.n. PERTH 06720544)**

*Shrub*, 0.4–0.6 m tall, *c.* 0.3 m wide. *Branchlets, leaf and inflorescence rachides* with moderately dense, mixed length, soft, fine, ascending to patent, silvery white indumentum, to 1.5 mm long. *Leaves* pinnate, up to 47 mm long including petiole, leaves and leaflets diminishing in size towards the apices of branches; *stipules* persistent, patent to reflexed, subulate, *c.* 5 mm long; *petiole* 2–10 mm long; *ultrajugal rachis* 1–3 mm long. *Leaflets* 5–13, oblanceolate to obovate, V-shaped in T.S., crowded, at least some in the proximal half of the leaf, apices rounded (terminal leaflet emarginate), deflexed, with a mucro *c.* 0.5 mm long; terminal leaflet to 10.5 mm long, to 5.5 mm wide; lateral leaflets to 18 mm long, to 5.2 mm wide; upper surface indumentum moderately dense, hairs ascending to almost patent, very fine, silvery hyaline, 0.2–0.3 mm long; lower surface indumentum denser than upper, hairs inclined to ascending, fine, silvery hyaline, *c.* 1.5 mm long; secondary veins obscure on lower surface, assessed on upper, in 6–8 off-set(?) pairs, intersecondary veins obscure, mid-vein narrow, raised on lower surface. *Inflorescence* axillary, flowers apparently paired; *bracts* not seen; *bracteoles* absent. *Pedicele* 2.3–2.5 mm long (to 5.1 mm on fruits). *Calyx* 3–3.2 mm long; tube 0.67–0.79 × the length of lateral lobes; upper lip shortly divided to 52–53% length; lower and lateral lobes narrowly deltoid, acuminate. *Flowers* orange, 3–4.7 mm long; standard claw not callused at base, apex broadly rounded; keel glabrous. *Staminal* tube glabrous, thickened on margins of fenestrae; vexillary filament glabrous, not callused. *Ovules* 6 seen, presumably also 7 [or more] based on seed number. *Pods* linear, curved towards apex, 29–40 × 4–4.5 mm, laterally compressed, depressed between seeds, with sinuous margin slightly indented between seeds; indumentum moderately dense, patent with a few or numerous longer, curved hairs, silvery hyaline; beak in line with upper suture, straight. *Seeds* 6–7 per pod, 4.8–5.3 mm between centres, obloid-reniform, laterally compressed, tapering to edges, 2.4–2.9 × 2.7–3.7 mm, mottled tan, brown and black, sometimes also with grey and orange-brown, testa smooth, hilum ±central; caruncle present, distinct, annular, cream. (Figure 32)

*Distribution and habitat.* Occurs in WA (VIB, CEK). Collected from between Wyndham and Kununurra, and from near Ellenbrae Homestead, on sandstone substrate, with *Triodia*, or in *Corymbia collina* or *E. miniata* woodland.

*Phenology.* Flowers observed February and May; fruits February to May, with mature seed in late April to late May.



*Conservation status.* Listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Smith 2017).

*Affinities.* *Tephrosia* sp. Saw Ranges is a distinctive species, readily distinguished from all others by the following combination of characters: an indumentum of white,  $\pm$ patent hairs; leaves with 2–6 pairs of crowded, obovate leaflets with rounded (the terminal leaflet emarginate), deflexed apices; small, apparently paired, axillary, orange flowers; fruits curved upwards towards apex, sinuous along margin, laterally compressed and depressed between seeds, which are compressed, obloid-reniform and finely mottled, with a distinct, cream, annular caruncle.



**Figure 32.** *Tephrosia* sp. Saw Ranges (D. Kabay s.n. PERTH 06720544). A – fruiting plant growing among sandstone rocks; B – leaves; C – immature fruit showing strong curve along length; D – mature fruit; E – dehiscent fruit showing laterally compressed seed with mottled testa and prominent caruncle. Image from R.L. Barrett & M.D. Barrett RLB 3061. Photographs © R. Barrett, used with permission.

It has superficial similarity to some collections of *T.* sp. E Kimberley Flora and to *T.* aff. *remotiflora* specimens at PERTH having crowded leaflets with deflexed apices. Both of these can be readily distinguished by their elongate pseudoracemose inflorescences; *T. remotiflora* and affiliates can be further distinguished by their pink/purple flowers.

### **Tephrosia sp. sparse pinnae (C.R. Michel 2202)**

Low, open to upright *subshrub* ('prostrate to decumbent' in Barrett & Barrett RLB 3082), 0.3–0.7 m tall (to 1.2 m wide in RLB 3082); stems may be reddish brown. *Branchlets, leaf and inflorescence rachides* glabrous to subglabrous, sometimes with very sparse, straight, appressed, white hairs 0.2–0.3 mm long. *Leaves* pinnate, up to 180 mm long including petiole; *stipules* persistent, antrorse (becoming spreading to reflexed in RLB 3082), subulate to narrowly triangular, 0.7–5 mm long; *petiole* 1.5–29 mm long, frequently short as proportion of total rachis; *ultrajugal rachis* 0–2 mm long. *Leaflets* 5–13, linear to filiform, flat to U-shaped in T.S., widely spaced, at least some in the proximal half of the leaf, apices acute to obtuse, straight to recurved; terminal leaflet 30–51 mm long, 0.5–0.6 mm wide; lateral leaflets 40–70 mm long, 0.5–0.6 mm wide; terminal shorter than adjacent laterals; upper surface glabrous to subglabrous, occasionally with scattered, appressed, short, white hairs; lower surface as above; short, white hairs often on petiolules; secondary veins obscure due to linear leaflets, intersecondary veins obscure. *Inflorescence* usually leaf-opposed pseudoracemes, sometimes also with axillary flowers at their base, to 300 mm long, with 2 or 3 flowers in each cluster (appearing paired, but with a late bud behind), sometimes with an axillary short shoot showing a number of scars from fallen flowers; *bracts* persistent; *bracteoles* not seen. *Pedicel* 2.5–12.5 mm long, gradually expanding into base of calyx on longer pedicels. *Calyx* 2–3 mm long, subglabrous or very sparsely appressed-hairy, with numerous small, golden glands (also seen on pedicels and developing floral bracts); tube 1–1.7 × the length of lateral lobes; upper lip broadly deltoid, shortly divided to 23–43% length; lower and lateral lobes deltoid, the lower lobe narrowly so. *Flowers* orange, petals gland-dotted, 4.3–6 mm long; standard claw callused at base, apex rounded to emarginate; keel glabrous. *Staminal* tube glabrous, slightly callused on margins of fenestrae; vexillary filament glabrous, slightly thickened above base. *Ovules* 6–8. *Pods* linear, gently upturned at apex, margins slightly indented between seeds with thickened sutures, 37–49 × 2.5–5.2 mm (slender pods seen in Kalumburu specimen), laterally compressed; glabrous to very sparsely hairy with appressed, short, white hairs; beak in line with upper suture, ±straight. *Seeds* 6–8 per pod, 5.5–7 mm between centres, pulvinate with rounded ends to transversely reniform-obloid, 2.1–3.2 × 3.1–4.2 mm, brown with minute to obvious black flecks or brown with light pink-brown and black spots, testa smooth, hilum slightly excentric; caruncle prominent, annular, cream. (Figure 33)

*Distribution and habitat.* Occurs in WA (NOK, CEK, VIB) and the NT. Grows in shallow soil among sandstone rocks on plains, slopes and upland pavements, in savannah woodland over grassland, or, when soil moisture is higher, a species-rich sub-storey of low shrubs, mixed perennial grassland, sedgeland and herbfield.

*Phenology.* Flowering from February to May, with sporadic flowers in June or July probably in response to rainfall. Fruiting commencing in February or March, with mature fruits and seeds collected in May, June and July.

*Affinities.* *Tephrosia* sp. sparse pinnae belongs to a complex comprising itself, *T. subpectinata*, *T. savannicola* (Qld), *T. sp.* E Kimberley Flora ( $\equiv$  *T. sp.* Crowded pinnae;

NT Herbarium) and *T. spechtii*. These taxa have very similar flowers, fruits and indumentum, and are currently distinguished primarily on leaflet characters (total number, spacing, length, width, L:W etc.). Within this complex, *T. sp. sparse pinnae* is most similar to *T. subpectinata*, differing in its generally fewer, more widely spaced, linear to filiform leaflets that are green on both surfaces (those of *T. subpectinata* are frequently distinctly discoloured and reddish on the lower surface), a glabrous to subglabrous facies (vs moderately densely appressed-hairy), shorter stipules and bracts, and significantly, in the presence of a usually large, annular caruncle on its seeds (caruncle absent in *T. subpectinata*).



**Figure 33.** *Tephrosia sp. sparse pinnae* (C.R. Michel 2202). A – leaf with three pairs of linear, lateral leaflets and the terminal leaflet not extended on an ultrajugal rachis; B – fully opened flower; C – flower showing calyx morphology and indumentum; D – immature fruit (6 seeds developing) with gently upturned apex. Images from R.L. Barrett & M.D. Barrett 3082. Photographs © R. Barrett, used with permission.

Extremely narrow-leafleted specimens of *T. sp.* Dunes collected from the Kiwirrkurra IPA resemble some specimens of *T. sp. sparse pinnae*, but are distinguished by their leaves having 3–5 leaflets positioned in the distal part of the leaf and with a long ultrajugal rachis, the densely hairy (loosely-appressed) calyx, hairy fruit with a downcurved beak, and transversely oblong (5–5.5 mm wide), light orange-brown seeds with a very small annular caruncle.

Collections of *T. sp. sparse pinnae* from Kalumburu (WA) have extremely fine leaflets and small flowers and are superficially similar to the NT taxon *T. nematophylla* F.Muell. This can be readily recognised by its growth form, having fascicles of stems arising from

a well-developed rootstock, its prominently corky stems, a higher number of filiform leaflets, pods that have the margin constricted between the seeds and an apex that is acute and has the beak central to both sutures.

*Notes.* Based on duplicate specimens distributed to PERTH from DNA, it would appear that some records there are mis-identified, linear-leaved specimens of *T. subpectinata*; for the most part these have been sterile or in fruit, with only a single fruit per specimen (hence unavailable for destructive sampling). The existence of these specimens in the PERTH collection has made it extremely difficult to characterise *T. sp.* sparse pinnae accurately to date. The Kalumburu collections of *T. sp.* sparse pinnae were difficult to place due to the false variation observed through the inclusion of *T. subpectinata* specimens.

### **Tephrosia sp. Willowra (G.M. Chippendale 4809)**

*Tephrosia* 'A4089 Willowra', *in sched.* [DNA, NT].

*Tephrosia* 'quinquefolia', *in sched.* [BRI; name still in use there].

Prostrate to spreading to rounded woody *herb* or erect *dwarf shrub*, to 0.6 m tall, to 1 m wide. *Branchlets, leaf and inflorescence rachides* slender, with moderately dense to dense, often very fine, patent to slightly ascending indumentum of usually white, occasionally stramineous hairs, 0.4–1 mm long. *Leaves* pinnate, up to 60 mm long including petiole; *stipules* persistent, antrorse at first then widely spreading, attenuate, 3.5–5.5 mm long; *petiole* 5–18 mm long; *ultrajugal rachis* 1.8–6.5 mm long. *Leaflets* 3–5(–7), elliptic, broadly oblong, narrowly obovate to obovate, usually flat in T.S., all positioned in the distal half of the leaf when 3-foliolate, some in the proximal half when 5(7)-foliolate, apices rounded to emarginate, straight but minute mucro often reflexed; terminal leaflet noticeably larger than laterals on most leaves, 11.5–31 mm long, 5.7–17 mm wide; lateral leaflets 6–15.5 mm long, 3.5–9 mm wide; upper surface with sparse to moderately dense, inclined, straight, white hairs, these soft to quite rigid; lower surface with indumentum denser and longer than upper, with inclined to patent, straight white hairs, these soft to quite rigid; secondary veins brochidodromous, in 6–11 pairs, intersecondary veins parallel at base, then reticulating, veins raised on lower surface, fine, cream to pink-red to deep red. *Inflorescence* pseudoracemose, leaf-opposed, usually with a cluster of axillary flowers at base, 10–90 mm long, with usually 3 flowers developing sequentially at each node, more in axillary clusters; *bracts* persistent; *bracteoles* persistent. *Pedicel* 2–6 mm long. *Calyx* 5–7.5 mm long; tube 0.35–0.5 × the length of lateral lobes; upper lip divided to 70–91% length; lower and lateral lobes lanceolate at base then filiform, *c.* equal in length. *Flowers* pink to scarlet, 5.5–7 mm long; standard scarcely callusing at base, apex rounded; keel glabrous. *Staminal* tube glabrous, margins of fenestrate inrolled, not significantly thickened and not callused, or slightly thickened with small rounded calluses at apex; vexillary filament glabrous, slightly geniculate at base, not or slightly callused. *Ovules* 6–8, ovary frequently thick-walled. *Pods* linear, upturned at apex to curved along length, 31–41 × 3–4.2 mm, laterally compressed, the sides indented between seeds at maturity; indumentum dense, somewhat tangled, the

hairs ascending, soft and thin, or patent and more coarse, white to pale stramineous; beak in line with the upper suture, straight to slightly deflexed. *Seeds* 5–8 per pod, 3.5–4 mm between centres, transversely obloid, 2.1–2.5 × 2.6–3.2 mm, finely mottled orange-light brown and brown with flecks of cream and black, testa smooth to broadly dimpled, hilum central; caruncle (?) a minute, cream, annular structure within the hilum.

*Distribution and habitat.* Occurs in WA (GSD, PIL), the NT and Qld. In WA, collected from orange loamy sand at a hill crest and near a fresh water wetland among sand dunes. Observed in the NT in orange-red sand in dune swales and on desert plains, and these habitats are commonly referenced on specimen labels. Grows in grassland with scattered to open woodland. Only recently determined to occur in WA, but probably widespread throughout the northern interior of the State.

*Phenology.* Likely to be an annual or biennial species. Plants seen near Kiwirrkurra (WA) and around Kintore (NT) in September 2015 were mostly dead with high numbers of fallen fruits and seeds. Plants were abundant at each site where the species was seen. From the specimens examined, flowers and fruits occur throughout the year (flowers: January, April–May, September–October; fruits: January, April–June, August–October; seed: April–May, September–October), possibly initiated by localised rainfall events.

*Affinities.* *Tephrosia* sp. Willowra is similar to *T. supina* and *T. sp.* Magazine Hill. Of the two, it is most similar to *T. supina* in the size, shape and indumentum of its fruits, its seed morphology, and its larger, flatter, elliptic to obovate leaflets, but can be readily distinguished by the following characters: leaves usually with 3 or 5 leaflets; the terminal leaflet usually distinctly larger than the adjacent laterals; the pseudoracemes much shorter; the calyx lobes long, slender and *c.* 1.5–3 × longer than the tube; the staminal tube and upper filament glabrous; the mature fruit being prominently indented between the seeds. The distinctive features of *T. sp.* Magazine Hill are discussed under that name.

Many specimens of *T. sp.* Willowra were originally identified as *T. flagellaris* Domin (from Qld) due to the prominently enlarged terminal leaflet, but this species can be distinguished by the following characters: 5–9 linear-oblong leaflets; terminal leaflet up to 4 × longer than the adjacent laterals; larger flowers (8–9 mm long); broader fruit with a straight apex.

Specimens of *T. sp.* Northern from the NT have been mis-identified as *T. sp.* Willowra there, presumably because of the enlarged terminal leaflet and very long, slender calyx lobes, but are readily distinguishable by their orange flowers and, if not flowering, by their straight, turgid fruits with spongy to membranous tissue between the more-boldly mottled seeds, and the leaves having 7+ leaflets with no indication of reddening of the venation.

*Notes.* There is variation in the size of the terminal leaflet relative to the laterals related to the age of the plant, and the leaves in question when the plant is mature. Herbarium specimens that are comprised of whole plant samples (i.e. include the tap-root) show that the first leaves and those near the base of stems have the terminal leaflets greatly



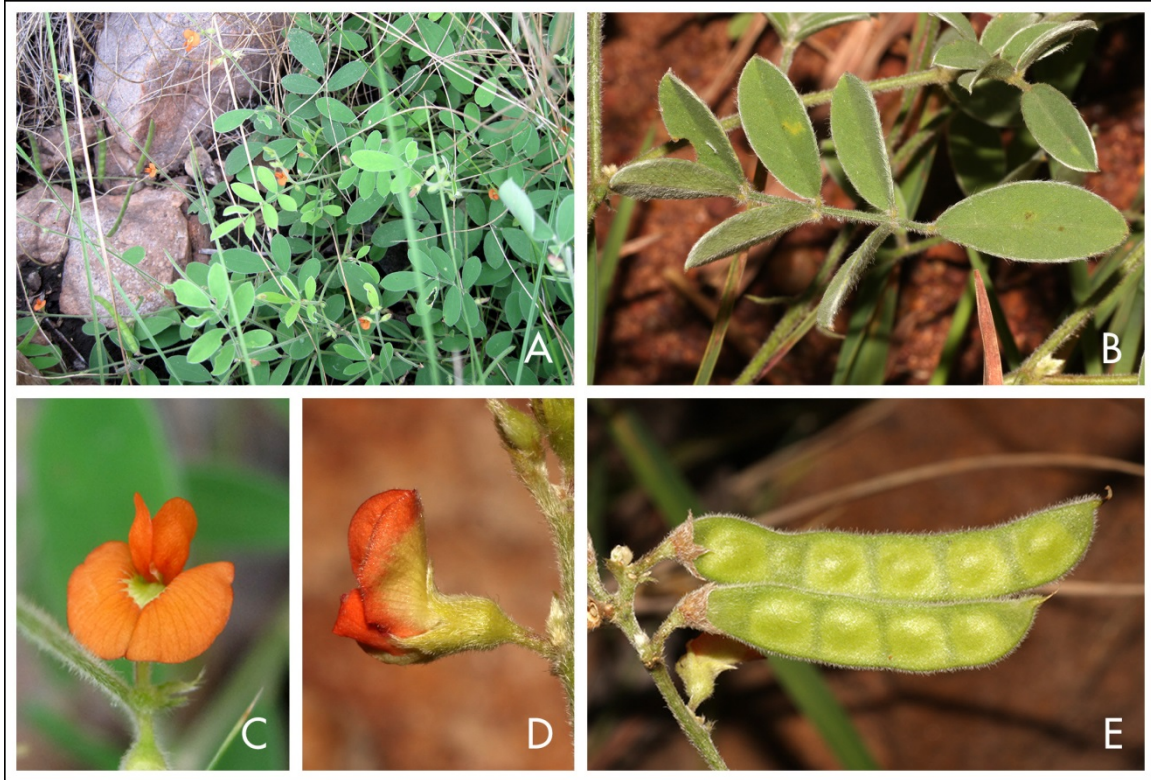
enlarged compared to the laterals, but that this relative enlargement diminishes along stems.

**Tephrosia sp. Yampi (A.N. Start per R.L. Barrett RLB 2291)**

*Subshrub*, 0.2–0.7 m tall, width not recorded but images show it is sprawling. *Branchlets, leaf and inflorescence rachides* with moderately dense, stiff, straight, patent to ascending, white indumentum, to 1.1 mm long. *Leaves* pinnate, 40–77 mm long including petiole, occasional unifoliolate leaves on flowering branchlets; *stipules* persistent, antrorse just at first then strongly reflexed with the apices frequently upturned (like a handlebar moustache), leaf-like, lanceolate to narrowly ovate, 4–6.5 mm long; *petiole* 7–24 mm long; *ultrajugal rachis* 3.4–8.2 mm long. *Leaflets* (3–)5–9(–11), almost oblong to elliptic to obovate, flat in T.S., at least some in the proximal half of the leaf, apices rounded, straight; terminal leaflet 7–30 mm long, 3.9–11.7 mm wide; lateral leaflets 7–17 mm long, 4–8 mm wide; leaflets gradually increasing in size from base to apex with terminal leaflet usually larger than adjacent laterals; upper surface appearing glabrous but with a moderately dense indumentum of short, gently ascending to patent, very fine, straight, silvery hyaline hairs; lower surface indumentum moderately dense, hairs ascending, straight, much longer than on upper, white; secondary veins brochidodromous, in 6–11 pairs, intersecondary veins obscure on lower surface, but visibly reticulate on upper surface, raised veins slender, yellowish. *Inflorescence* elongate, leaf-opposed pseudoracemes, often with a cluster of flowers in the leaf axil, 9–153 mm long, with 2, possibly 3, flowers in each cluster; *bracts* persistent; *bracteoles* absent. *Pedicel* 2.2–3 mm long. *Calyx* 3–3.7 mm long, moderately to densely hairy; tube 0.9–1.13 × the length of lateral lobes; upper lip shortly divided to 27–40% length; lower and lateral lobes deltoid, acuminate. *Flowers* orange, 4–6.5 mm long; standard claw not callused at the base, apex rounded, shortly and broadly emarginate; keel with a few hairs along lower margin near apex. *Staminal* tube glabrous, not callused; vexillary filament glabrous, not callused. *Ovules* 7 seen (8+ possible based on seed number). *Pods* linear, ±straight, 35–40 × 3.8–4.3 mm, laterally compressed and indented between seeds, the sutures somewhat thickened; indumentum moderately dense, patent, hyaline to white; beak in line with the upper suture, straight to distinctly down-curved. *Seeds* 6–8 per pod on long funicles (0.6–0.8 mm long), 4.5–5 mm between centres, lenticular but oblique on lower edge, 2.2–3 × 2.2–3.1 mm, darkly mottled, chocolate brown with tan-grey-brown and purplish grey-brown and black streaks, testa smooth, hilum ±central; caruncle minute, annular, opaque. (Figure 34)

*Distribution and habitat.* Occurs in WA (CEK). Collections have been made from Yampi Peninsula eastward to the Phillips Range. Mostly collected from sandstone, with one record stating ‘sand over quartzite’. Grows in open *Corymbia* or mixed woodland over grasses (e.g. *Sorghum*, *Triodia*) and shrubs.

*Phenology.* Flowers recorded in March, also fruits, with these mature and bearing seed in May.



**Figure 34.** *Tephrosia* sp. Yampi (A.N. Start per R.L. Barrett RLB 2291). A – plant sprawling among sandstone rocks; B – leaf showing elliptic leaflets with margin of hairs from lower surface; C – resupinate flower from front; D – flower from side showing calyx morphology and indumentum; E – immature fruits (4 and 5 seeds developing). Images from H. Dauncey H 529 (A, C) and A.N. Start per R.L. Barrett RLB 2291 (B, D, E). Photographs © H. Dauncey (A, C) & © R. Barrett (B, D, E), used with permission.

*Affinities.* *Tephrosia* sp. Yampi is a distinctive species readily recognised by its strongly deflexed stipules, which resemble a handlebar moustache, its usually 5–9, elliptic leaflets that appear glabrous on the upper surface (actually very finely hairy) and have a distinct border of white hairs (formed from hairs that protrude beyond the margin from the appressed-hairy lower surface), its linear,  $\pm$ straight, laterally compressed fruits, which are flattened between the seeds and have slightly sinuous margins, and seeds that are mottled purplish dark brown and have a very long funicle (also evident in ovule attachment).

It is closely allied to *T. crocea*, which also has leaf-like, recurved stipules, but this species has smaller, more numerous (15–51), obtusely cuneate leaflets that reduce in size from the base of the leaf to the apex and have more prominent venation. It also differs in its fruits and seeds, the pods having a long, ascending beak and the seeds being uniformly tan to lightly mottled (yellow-tan with dark flecks), ellipsoid (c. 2.8–2.9  $\times$  3.7–3.8 mm), attached to the placenta by short funicles (0.2–0.3 mm long), and lacking a caruncle.

*Tephrosia* sp. Yampi has some similarity to *T. sp. Northern* in the number and shape of its leaflets, but this can be distinguished by its eucamptodromous to apically brochidodromous secondary leaflet venation (with indistinct intersecondary veins),

antrorse to inclined stipules, larger flowers with elongate calyx lobes (to 7 mm long) that are characteristically longer than the tube, turgid pods, and ellipsoid seeds.

*Notes.* Two of the specimens (*A.N. Start per R.L. Barrett* RLB 2291; *R.L. Barrett & T. Handasyde* RLB 1984) were originally identified as being a hairy form of *T. remotiflora*; this is superficially similar but has smaller, purple flowers, reddish venation on leaflets, and narrower fruits with fine, appressed or patent hairs.

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## ***Glossary of taxonomic terms and symbols in this report***

**AD:** State Herbarium of South Australia, Adelaide, SA.

**aff.:** *affinis*; akin to, bordering.

**ascending:** angled obliquely upwards, usually curved.

**auct.:** *auctorum*, of authors. Used to indicate that a name is used in the sense of (one or many) subsequent authors and not in its (different) sense as established by the original author, e.g. *T. supina auct.* Wheeler (1992) = *T. sp.* Northern (K.F. Kenneally 11950).

**auct. non:** Used to indicate a name that has been misapplied, e.g. *T. supina auct. non* Domin – the concept of *T. supina* that has been applied by (one or many) subsequent authors, but not as specified by Domin, the original author.

**BRI:** Queensland Herbarium, Brisbane, Qld.

**brochidodromous:** with the secondary vein curving before the margin and joining the vein above to create a series of loops.

**CANB:** Australian National Herbarium, Canberra, ACT.

**cf.:** *confer*; compare with.

**confirmavit:** specialist annotation on a herbarium specimen confirming an identification.

**craspedodromous:** with the secondary veins parallel, straight to margin.

**Declared Rare Flora (DRF):** Extant; taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee (= *Threatened Flora* = *Endangered* + *Vulnerable*).

**determinavit:** specialist annotation identifying (determining) a specimen as a particular taxon.

**DNA:** Northern Territory Herbarium, Palmerston, NT.

**erect:** at 90° relative to horizontal axis or plane.

**eucamptodromous:** with the secondary veins curving before the margin of the leaf.

**flora:** all of the plant species within a particular geographic area.

**Flora:** a written account of the plant species within a particular geographic area, including descriptive information and keys to identification.

**holotype:** the one specimen or other element used or designated by the original author at the time of publication of the original description as the nomenclatural type of a species or infraspecific taxon.

***in sched.:*** *in schedula*; written on a herbarium sheet or label.

**inclined:** rising upward at a moderate angle.

**intersecondary veins:** veins arising from the midvein, positioned between the secondary veins, and not reaching the margin.

**isotype:** any duplicate of the holotype (i.e. part of a single gathering made by a collector at one time, from which the holotype was derived).

**isosyntype:** any duplicate of a syntype (see below).

**K:** Herbarium of the Royal Botanic Gardens, Kew, London, England.

**lectotype:** a specimen or other element designated subsequent to the publication of the original description from the original material to serve as nomenclatural type.

**MEL:** National Herbarium of Victoria, Melbourne, Vic.

**ms:** *manuscriptum*; manuscript. Used after a name that has been proposed but has not yet been validly published (manuscript name).

**NSW:** New South Wales National Herbarium, Sydney, NSW.

**NT:** Northern Territory Herbarium, Alice Springs, NT.

***p.p.:*** *pro parte*; indicates more than one taxon under that name, with the corresponding name matching one, not all, of the forms currently included under that name.

**patent:** at 90° relative to vertical axis or plane.

**PERTH:** Western Australian Herbarium, Perth, WA.

**phenetic:** taximetric analyses that group organisms on their observed similarities without regard for their evolutionary relationships.

**phrase name:** an informal name given to a taxon believed to be distinct, but not yet resolved or published. A phrase name consists of the genus name, a geographic or descriptive qualifier, and a voucher specimen reference, which links the name to a

physical specimen, much like a type. Phrase names are included on the Western Australian vascular plant census.

**Priority One:** Poorly Known; taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, or the plants are under threat. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

**Priority Two:** Poorly Known; taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

**Priority Three:** Poorly Known; taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.

**resupinate:** [of flowers] upside down, due to twisting of the pedicel.

*s. dat.:* without date.

*s. lat. (s.l.): sensu lato;* in the broad sense.

*s. str. (s.s.): sensu stricto;* in the strict sense.

**secondary veins:** the veins that are attached to the midvein (along its length or from its base) that extend to the margin.

**semireticulodromous:** with the secondary (or intersecondary) veins becoming reticulate before the margin.

**sp.:** species. Notation often used (e.g. *Triodia* sp.) when a specimen has not been or cannot be assigned to a known taxon.

*sp. nov.:* *species nova*; new species.

**spreading:** extending nearly to the horizontal

**subsp.:** subspecies; a taxonomic rank below the level of species.

**synonym:** a name that applies to a given taxon but is not the accepted name.

**syntype:** one of a series of specimens used to describe a species or infraspecific taxon when neither a single holotype nor a lectotype has been designated.



**type:** the specimen, specimens, illustrations or plates upon which a taxonomic name is based.

**var.:** variety; a taxonomic rank below the level of species and generally thought to be either below or commensurate with the rank of subspecies.

! [in citations for species] ‘I have seen this [specimen].’

≡ synonymous.

≠ does not equal; is not the same as.

± more or less; a little to either side of [*not* ‘present or absent’].

**Appendix 1.** Characters and states used in the morphometric analysis of orange-flowered segregates from *Tephrosia supina*. Asterisked (\*) characters were excluded from the analysis for which the results are presented here as many specimens lacked mature fruits.

| Character                                                      | Code in analysis |
|----------------------------------------------------------------|------------------|
| <b>Quantitative (continuous)</b>                               |                  |
| Lowest leaflet length (mm)                                     | lowest L         |
| Terminal leaflet length (mm)                                   | term L           |
| Terminal leaflet width (mm)                                    | term W           |
| Mucro length (mm)                                              | mucro L          |
| Leaf midrib (rachis) length (mm)                               | midrib L         |
| Petiole length (mm)                                            | petiole L        |
| Stipule length (mm)                                            | stip L           |
| Calyx tube length (mm)                                         | calyx TL         |
| Lateral calyx lobe length (mm)                                 | lat L            |
| Upper calyx lobe fusion (mm)                                   | upp fusion       |
| Pod length (mm)*                                               | pod L            |
| Pod width (mm)*                                                | pod W            |
| <b>Quantitative (ordinal)</b>                                  |                  |
| Number of leaflets                                             | # leaflets       |
| Number of pairs of 2° veins                                    | # veins          |
| Number of ovules                                               | # ovules         |
| <b>Ratio/proportion</b>                                        |                  |
| Terminal leaflet length:width ratio                            | term L:W         |
| Lowest leaflet length as proportion of terminal leaflet length | lowL/termL       |
| Calyx tube as proportion of upper calyx lobe length            | tube prop upp    |
| Proportion of upper calyx lobes fused at base                  | prop fused       |
| Petiole length as proportion of leaf rachis length             | pet prop L       |
| <b>Qualitative binary/mutistate</b>                            |                  |
| Stipule orientation                                            | stip orient      |
| 0 = erect                                                      |                  |
| 1 = divergent                                                  |                  |
| 2 = spreading                                                  |                  |
| 3 = deflexed                                                   |                  |
| Keel apex hairy                                                | keel hairy       |
| 0 = no                                                         |                  |
| 1 = yes                                                        |                  |
| Pod apex curvature*                                            | pod apex         |
| 0 = straight or almost straight                                |                  |
| 1 = gently upturned                                            |                  |
| 2 = upturned                                                   |                  |
| Pod beak orientation*                                          | beak orient      |
| 0 = straight                                                   |                  |
| 1 = downcurved                                                 |                  |
| Venation pattern                                               | veins            |
| 0 = +/- craspedodromous; intersecondaries obscure              |                  |
| 1 = distinctly brochidodromous; intersecondaries reticulate    |                  |