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NOTES ON THE GENUS *TRIBULOPIS* (ZYGOPHYLLACEAE) IN AUSTRALIA

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Abstract

A background is given to the genus *Tribulopsis* R. Br. (Zygophyllaceae), an Australian endemic. The genus is lectotypified as are a number of species. Two new combinations, *Tribulopsis homalococca* (Domin) R.M. Barker and *Tribulopsis homalococca* var. *alifer* (Domin) R.M. Barker are made and three possibly new taxa are described but not given formal status because of the limited material available. A key, notes on distribution and habitat, comments on variability and dispersal of the taxa and their distinguishing features, all or selected specimens and illustrations are provided for all of the taxa.

Background

Tribulopsis was first described as a genus distinct from *Tribulus* L. by Robert Brown (1849) in the Appendix to Sturt's Expedition into Central Australia. According to Brown, he had recognised the genus 40 years before, and there is no reason to doubt this since the three species he described (*T. pentandra* R. Br., *T. angustifolia* R. Br. and *T. solandri* R. Br.) were all based on his own collections from northern Australia. Mueller (1858), in describing a fourth species in the genus, *T. bicolor*, erroneously referred it to '*Tribulopsis*', thus causing confusion as to the correct spelling. He later (Mueller, Feb. 1862) reduced *Tribulopsis* (still as '*Tribulopsis*') to a subgenus of *Tribulus* as did Bentham & Hooker (Aug. 1862), although it has been the latter who have been attributed with this reduction in the past.

This latter placement of the species within *Tribulus* was followed by the majority of workers until the 1960's. One exception was Engler & Prantl (1890), who transferred a number of Australian *Tribulus* and *Tribulopsis* species to *Kallstroemia* Scop. As a result there have been sporadic listings of this genus for Australia (e.g. Burbidge 1963, Beard 1965). It was not until Porter (1969) considered the generic relationships of *Kallstroemia*, and restricted it to the Americas, that *Tribulopsis* was again considered at generic level. Porter advocated its resurrection, indicating that *Tribulopsis* could be distinguished from *Tribulus* by its single ovules per locule (versus 2-5 in *Tribulus*).

Porter considered the genera *Tribulus*, *Tribulopsis*, *Kallstroemia* (c. 17 American species) and *Kelleronia* (c. 10 North African species) to form a natural assemblage within Zygophyllaceae, sharing the characteristics of prostrate herbs with opposite, even-pinnate leaves, pentamerous flowers with 10 stamens in 2 unequal rows and without any appendages on the filaments, indehiscent fruits and polyforate pollen. On this basis he (Porter 1972) proposed the subfamily Tribuloideae to include these genera, but excluded the genera *Neoluederitzia* and *Sisyndite* which had previously been treated as part of this group. Recent phylogenetic work on Zygophyllaceae by Sheahan & Chase (1996), based on morphological, anatomical and rbcL DNA sequences, has reinstated the genera excluded by Porter into the subfamily Tribuloideae, with the possible addition of *Balanites* as well.

Keighery (1982) published an account of geocarpy in the fruits of *Tribulopsis* and also considered the generic status of *Tribulopsis*, recommending its readoption and listing a suite of characters associated with the geocarpic dispersal syndrome. New combinations in *Tribulopsis*, without any discussion of generic status, were made by Eichler (1984) in preparation for the Western Australian plant census (Green 1985).

While the species involved are now usually referred to *Tribulopsis*, there has been no treatment of the whole genus Australia wide, since that of Bentham. Lawrence's (1992) treatment considered all of the presently named species but was restricted to the Kimberley region.

Tribulopsis, *Tribulus* and *Kallstroemia*

Characters used to separate *Tribulus* and *Tribulopsis* in the past include

- alternate leaves in *Tribulopsis* vs opposite leaves in *Tribulus*
- fruits pyramidal in *Tribulopsis* vs non-pyramidal in *Tribulus*
- style and stigma persistent in *Tribulopsis* vs style and stigma deciduous in *Tribulus*
- ovules 1 per cell in *Tribulopsis* vs ovules 2–5 in *Tribulus*

While these characters work most of the time, there are exceptions, and it is possible that there are no uniquely derived characters to separate the two genera. The opposite leaves of *Tribulus* are usually markedly unequal in size and in many of the Australian species, the smaller of the pair may be completely suppressed, giving an apparent alternate leaf arrangement, as in *Tribulopsis*. The pyramidal fruit so characteristic of *Tribulopsis* is also apparent in *Tribulus astrocarpus* F. Muell. Indeed it is comparatively easy to envisage the fruits of this species as a precursor to those of *Tribulopsis* or vice versa. The style and stigma persist on the apex of the fruit of *T. astrocarpus* just as they do in *Tribulopsis* species, and investigation of all Australian *Tribulus* species reveals the presence of the style and stigma in the mature fruit before breakage into fruitlets.

The greater number of ovules per cell in *Tribulus* when compared to *Tribulopsis* would appear to have only one exception. Investigation of *Tribulus platypterus* Benth. reveals that it shares with *Tribulopsis* the single ovule per cell. However its sister species, *T. suberosus* H. Eichler ex R.M. Barker, has two ovules per cell. Both *T. platypterus* and *T. suberosus* are unique in this grouping by their shrubby habits (see Barker 1998).

One character which has been used to some effect here is the size of the leaflet pairs becoming larger towards the apex of the leaf in *Tribulopsis* but smaller in *Tribulus*.

Species of both *Tribulus* and *Tribulopsis* were assigned to *Kallstroemia* in the past but there is little doubt that the Australian species are distinct from the American *Kallstroemia*. That genus is characterised by its 10-lobed ovary and stigma rather than the 5-lobed state found in *Tribulopsis* and *Tribulus*. *Tribulopsis* shares with *Kallstroemia* the 1-ovulate state and a very similar fruit morphology (see Porter 1969, Fig. 1–16).

Present status of species assigned to *Tribulopsis*

T. pentandra R. Br., *T. angustifolia* R. Br., *T. sessilis* (Domin) H. Eichler, *T. bicolor* F. Muell., *T. solandri* R. Br. and *T. homalococca* (Domin) R.M. Barker are all recognised at species level below, together with four other potentially new taxa.

T. pentandra R. Br. is widespread across northern Australia and usually easily recognisable by its 5 stamens and leaves with 2 pairs of leaflets. Two potentially new taxa, related to *T. pentandra*, have been recognised from the Kimberley region of Western Australia, one from the Koolan Island area and the other from the Mitchell Plateau.

T. angustifolia R. Br. displays a great deal of variation. Lawrence (1992) reduced the previously recognised *T. curvicarpa* (W. Fitzg.) Keighery and *T. affinis* (W. Fitzg.) H. Eichler to synonyms of *T. angustifolia*, a decision which has been followed here, along with reduction of *Tribulus leptophyllus* Bailey to a synonym of this species. However it would not be surprising if some infraspecific taxa were to be recognised in the future. Extensive field work and herbarium study will be required if there is to be an understanding of the

variation involved. A potentially new taxon, restricted to the Mt Isa area, is most closely related to *T. angustifolia*.

Tribulopsis solandri R. Br. was recorded from the Kimberley's by Lawrence but this species has been restricted to Cape York Peninsula in this treatment. Those species in Western Australia previously referred to *T. solandri* are now referred to *T. bicolor* F. Muell. It is possible that *T. solandri* and *T. bicolor* may not prove to be specifically distinct with further study across the range. Characters to separate the two are difficult to find, but the species level has been maintained for the present. A potentially new taxon confined to Lizard Island is most closely related to *T. solandri*.

The four potentially new taxa all appear to be quite distinct, but the small number of collections involved and the lack of notes associated with the collections, make it premature to recognise them formally. Any extra collections of any of these taxa would be greatly appreciated by the author. Flowering and fruiting is associated with the end of the wet season and good collections of most species are normally made from February to May.

Additional notes on floral characteristics and fruit dispersal would also be useful. Confirmation of Keighery's notes on the geocarpy of certain species is also needed. It seems much more likely in those species in which the pyramidal fruits split into fruitlets at maturity that hydrochory, or even zoochory, might be involved in dispersal of these plants. The brittleness of the mature fruits and their readiness to break into fruitlets suggests similarities to *Tribulus* and its "trample" mechanism of dispersal, but the outgrowths in the form of paired bumps or rounded "spines" are not really designed for adherence to the trampler.

The author would be pleased to hear of any comments on the following treatment in order that the manuscript can be upgraded before its inclusion in the *Flora of Australia*.

TAXONOMIC TREATMENT

Descriptions have not been included for those species which have already been published, only those taxa which are potentially new. All of the specimens seen have been cited for a particular taxon unless otherwise indicated.

TRIBULOPIS R. Br. in Sturt, *Expedition into Central Australia 2 App.* 70 (1849); H. Eichler, *Fl. Central Austral.* 184 (1981); Keighery, *Flora* 172: 333 (1982); H. Eichler, *Nuytsia* 5: 177 (1984); Lawrence, *Fl. Kimberley Region* 675 (1992).
Lectotype here designated: *T. angustifolia* R. Br.

Tribulopsis F. Muell., *Fragm.* 1 (1858) 47, orthographic variant.

Tribulus subg. *Tribulopsis* (R. Br.) F. Muell. (as '*Tribulopsis*'), *Pl. Indig. Colony Vict.* 1: 99 (Feb. 1862); Hook. in Benth. & J.D. Hook., *Gen. Fl.* 1: 264 (Aug. 1862).

Tribulus auct. non L.: Benth., *Fl. Austral.* 1: 287 (1863) p.p. (only with respect to *T. pentandrus*, *T. bicolor*, *T. solandri* and *T. angustifolius*); F.M. Bailey, *Queensl. Fl.* 1: 171 (1899); Ewart & Davies, *Fl. N. Terr.* 154–156 (1917); Domin, *Biblioth. Bot.* 89: 280 (1926) p.p.

Kallstroemia auct. non Scop.: Engl. in Engl. & Prantl, *Die Nat. Pflanzenfam.* 3(4): 88 (1890) p.p. (only with respect to *K. angustifolia*, *K. bicolor*, *K. pentandra* and *K. solandri*)

Prostrate, usually pubescent annual or short-lived perennial herbs. *Leaves* alternate, not succulent, stipulate, the stipules markedly unequal, 2–6-foliolate; leaflets not continuous with petiole, not stipellate; petiole terete. *Flowers* solitary. *Pedicel* usually erect in flower, deflexed in fruit. *Sepals* 5, not persistent in fruit. *Petals* 5, free, quickly deciduous, yellow, not fading to white, longer than sepals. *Stamens* 10 or fewer, usually in 2 subequal whorls; filaments not winged. Extrastaminal nectariferous disc lobes 5; intrastaminal disc 5 free

lobes or sinuate ring or lacking. *Ovary* 5-celled; ovules 1 per cell; style short; stigma 5-ridged, papillose. *Fruit* a pyramidal schizocarp topped by persistent style and stigma, pendent, dissociating into 1–5, indehiscent, smooth or reticulate mericarps, often with pair of basal or median conical spines or protuberances, rarely with a semicircular wing.

C. 10 species, endemic to northern Australia. Flowering towards the end of the wet season.

Typification

In recognising the genus *Tribulopsis*, Brown (1849) commented on the distinction of the American species of *Tribulus* L. from the rest of the species of *Tribulus* proper by their “10 monospermous cocci, by their persistent calyx, and the absence of glands subtending the 5 filaments opposite to the sepals.” This group of species had been recognised as a separate genus, *Kallstroemia*, by Scopoli. Brown commented that there was a further genus which he had recognised 40 years previously in the Banksian Herbarium, which he called *Tribulopsis* which could be distinguished by its deciduous calyx, 10 stamens (reducing to 5), glands subtending the 5 filaments opposite the sepals and the 5 monospermous cocci often with 2 or 4 tubercles at their base. All were prostrate annual herbs with all leaves alternate. He described 3 species, *T. solandri*, *T. angustifolia* and *T. pentandra*, all of which are available for lectotypification of the genus.

All three species fit the description given above. However *T. pentandra* has 5 rather than the normal 10 stamens for the genus and so is somewhat atypical. Either of the other two species would serve equally well as type species of the genus but *T. angustifolia* has been chosen rather than *T. solandri* because it is much more common and widespread.

Provisional key to *Tribulopsis*

- 1 Leaflet pairs 2 throughout the plant; stamens 5–7
 - 2 Mericarps straight dorsally and with a pair of diverging basal spines [petals 4.5–11 mm long; style 1–4 mm long, thickened; widespread] 1. *T. pentandra*
 - 2: Mericarps curved dorsally, lacking basal spines but median and basal protuberances sometimes present
 - 3 Mericarps 1–3 per fruit, reticulate on dorsal surface; style thickened 3. *T. aff. pentandra* (Koolan Island)
 - 3: Mericarps 1 per fruit, smooth on dorsal surface, style slender 2. *T. aff. pentandra* (Mitchell Plateau)
- 1: Leaflet pairs more than 2; stamens 10 (including staminodes)
 - 4 Leaflets linear to narrowly ovate; leaflet pairs usually more than 3
 - 5 Lowest pair of leaflets inserted very close to stem; ovary and fruits glabrous; [leaflet pairs 4–5; Kimberleys to Victoria River and Julia Creek area of Qld, on alluvial silts or black or grey cracking clay] 5. *T. sessilis*
 - 5: Lowest pair of leaflets inserted well above stem; ovary and fruits pubescent
 - 6 Ovary covered with white appressed hairs; petals 5–7.5 mm long; mericarps 5–6 mm high, appressed pubescent, with median and basal spines [leaflet pairs 4–5; Mt Isa area] 7. *T. aff. angustifolia* (Mt Isa)
 - 6: Ovary covered with dense white erect hairs; petals 3.5–16 mm long; mericarps 5–11 mm high, unarmed, with basal spines only or with median and basal spines, smooth or reticulate dorsally; [leaflet pairs (2-)3–5(-6); across northern Australia, north of the Tropic of Capricorn] 6. *T. angustifolia*
 - 4: Leaflets elliptic, ovate or obovate; leaflet pairs usually 3;
 - 7 Flowers yellow throughout or with orange or darker centre; lower leaflet pair often inserted close to stem; stamens 5 fertile (globular anthers), 5 staminodal (linear anthers); ovary seated on obvious

sinuate disc [southern Kimberleys in WA through to Victoria River in NT, with extra populations in Katherine and the McArthur River]..... 4. *T. bicolor*

7: Flowers yellow throughout; lowest leaflet pair inserted well above stem; stamens 10 fertile or 1–6 staminodal; ovary with 5 intrastaminal disc glands or with very narrow ring at base

8 Fruits markedly rounded dorsally, sometimes with semicircular wing at base, lacking spines; [slender delicate herbs; young parts with curled white appressed hairs; Cape York Peninsula]..... 10. *T. homalococca*

8: Fruits +/- straight dorsally, with median and basal spines or protuberances

9 Ovary glabrous; fruits glabrous, with median and basal "bumps", not spines; young parts glabrous [Lizard and Flinders Islands off Cape York Peninsula]..... 9. *T. aff. solandri* (Lizard Island)

9: Ovary with 5 bundles of lax white hairs; fruits glabrous or pubescent, with median and basal spines; young parts with curled white hairs [Cape York Peninsula in sand or basalt]..... 8. *T. solandri*

1. *Tribulopsis pentandra* R. Br. in Sturt, *Expedition into Central Australia 2 App.* 70 (1849); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 676 (1992); – *Tribulus pentandrus* (R. Br.) Benth., *Fl. Austral.* 1: 290 (1863); Ewart & Davies, *Fl. N. Terr.* 156 (1917); W. Fitzg., *J. Proc. Royal Soc. W. Austral.* 3: 157 (1918); Domin, *Biblioth. Bot.* 89: 280 (1926); *nom. illeg.*, predated by *Tribulus pentandrus* Forssk. (1775); – *Kallstroemia pentandra* (R. Br.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 88 (1890); – *Tribulus brownii* F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862); F. Muell., *Systematic Census Austral. Pl.* 13 (1882); F. Muell., *Sec. Systematic Census Austral. Pl.* 23 (1889); replacement name for *Tribulus pentandrus* (R. Br.) Benth.

Type citation: In insulis juxta fundum sinus Carpentariae Anno 1803, R. Brown.

Type collections: Carpentaria, Islands [Morgans Island], 21 Jan. 1803, R. Brown 21 [J.J. Bennett no. 5219]; BM, BRI 118539, K, (all seen as photographs in Eichler collection of protologues), MEL s.n., MEL(ex E), NSW391137.

Tribulopsis bijuga R. Br. MS on specimens and in Brown's unpublished manuscript.

Occurs in Western Australia, Northern Territory and Queensland in a variety of situations ranging from quartzite, sands and sandstones to cracking clay and limestone pavement. Flowers and fruits Jan. - May, rarely Nov. Fig. 1, A–C.

Notes

Where it occurs in rock crevices the fruits may curve down and burrow into the soil (geocarpic), but this characteristic seems not to be as strongly developed in other situations since mature fruits with dissociated mericarps are to be found on a number of specimens.

Specimens in which the fruits are topped with a very short and broad style are frequently bud autogamous (e.g. *J.Egam 3198, Harris 524*)

A single specimen collected from the Bungle Bungles in November (*Menkhorst 777*) was the only collection from outside the months of January to May. It was more robust than usual and already had flowers and fruits present on it, but apparently did not differ in any other respect from *T. pentandra*.

Stamen number is usually 5, but there are variations on this. A number of specimens had 5 fertile stamens and 2–3 smaller staminodes. One specimen agreed in every other characteristic with *T. pentandra* but had 10 fully fertile anthers (*Alvin 77*). Other specimens had 4 fertile stamens with one other filament either with a tiny undeveloped anther or a long linear anther.

Distinguishing features

The *Tribulopsis pentandra* group is distinguished from the rest of the species of *Tribulopsis* by the stamen number of 5–7 and the 2 pairs of leaflets. The Koolan Island and Mitchell Plateau taxa recognised below are part of the complex, but both differ from true *T. pentandra* in fruit characters. This difference may be related to the breeding system but further collections and field observations are required for a better understanding of the variation involved.

Selected specimens examined

WESTERN AUSTRALIA: behind tailings dam at Argyle Diamond Mines, *L. Alvin* 77 (PERTH); Red Rock Creek, Bungle Bungle N.P., *K.A. Menkhorst* 777 (DNA); Dead Horse Spring, near Argyle Village, just off the road from Duncan Hwy to Ord River Dam, *Hj. Eichler* 22224 (CANB, CHR, DNA, L, MO, NSW, P, PERTH).

QUEENSLAND: 2 km along Royal Arch road from Gulf Development Rd (W of Chillagoe), *K.L. Wilson* 8094, *J. Clarkson* & *S. Jacobs* (CANB, MBA, NSW); Pannikan Springs area, 29 km W of Mungana, *A.R. Bean* 5601 & *P. Forster* (BRI, CANB, MEL); Ridge W of Hilton, 20 km N of Mt Isa, *A. Schmid* 623 (BRI); Tick Hill, 44 km E of Dajarra, *Harris* 524 (BRI)

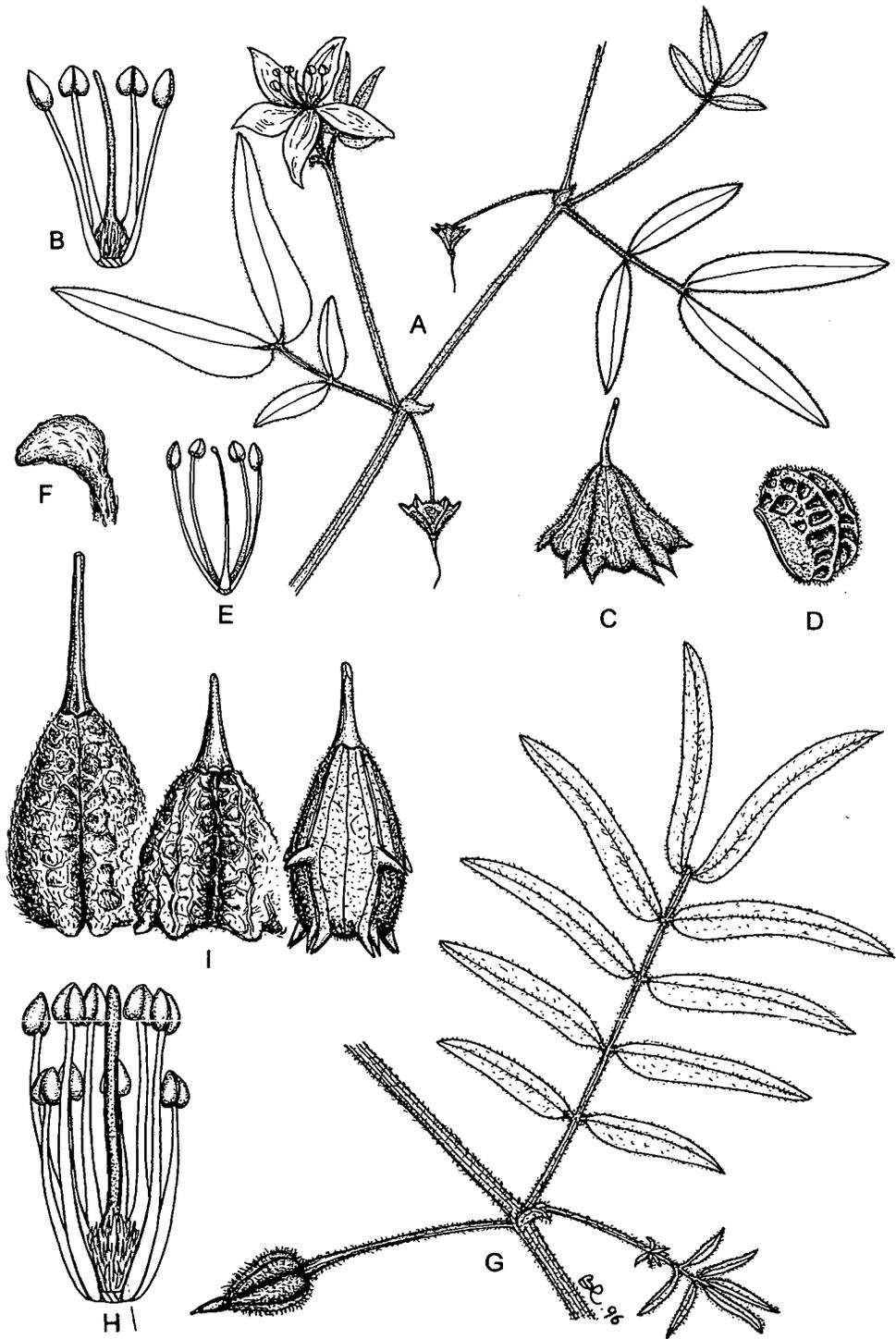
NORTHERN TERRITORY: Keep River N.P., *C.R. Dunlop* 5723 (DNA, MEL, NSW); Stuart Hwy, 26 miles N Newcastle Waters turnoff, *J. Must* 395 (DNA, PERTH); Mataranka, *J. Egan* 3198 & *I. Cowie* (DNA).

2. *Tribulopsis* aff. *pentandra* (Mitchell Plateau)

Prostrate, annual *herb*, sometimes forming mats; stems to 30 cm long, usually hirsute with spreading white hairs. *Leaves* with 2 pairs of leaflets, the lowest pair inserted well above stem; leaflets narrowly elliptic, shortly petiolulate, oblique, acute/acuminate, subglabrous adaxially (upper), white appressed hairs abaxially (lower), upper pair +/- erect, 8–12(-21) mm long, 2–3(-6) mm wide, lower pair smaller, spreading. Flowering pedicel c. 5 mm long, upright, fruiting pedicel 3.5–25 mm long, deflexed, thickened. *Sepals* c. 3 mm long, glabrous adaxially (inner), white-appressed hairs abaxially (outer); margin hyaline. *Petals* yellow throughout, narrowly obovate, 3.5–6.5 mm long, longer than sepals. Extrastaminal glands 5, intrastaminal glands absent. *Stamens* 5, at maturity equal to stigma; filaments c. 2 mm long (c. 1 mm long in smaller flowers); anthers c. 0.5 mm long (0.2 mm long in smaller flowers). *Ovary* appressed white pubescent or glabrous, 5-lobed; style (including stigma) 2 mm long, very slender. *Fruit* with dense short erect pubescence, of 1 tardily dissociating, fully developed mericarp, 1.8–2.5 mm high, dorsally curved, smooth, unarmed or possibly with pair of basal protuberances. Fig. 1, E–F.

Known only from the Mitchell Plateau in the Kimberleys of Western Australia. Larger-flowered specimens are recorded from shallow soils over sheets of exposed basalt and smaller-flowered specimens from *Eucalyptus latifolia* woodland. Keighery, who also noted this difference (Keighery 1982), observed that the smaller-flowered specimens were self pollinating. Flowers Jan.–Feb.

Fig. 1. A–C, *Tribulopsis pentandra* A, Habit (x2); B, Flower (x8) with petals and one stamen removed, both *Must* 395; C, fruit with style attached (x5), *Leutert* 86; D, *T. pentandra* (Koolan Island), fruit segment (x5); E–F, *T. pentandra* (Mitchell Plateau) E, flower with petals and one stamen removed (x8) *Kenneally* 7935; F, stigma (x8), *Keighery* 2630; G–I, *T. angustifolia* G, habit (x2) *Thomson* 1853; H, flower (x8) with petals and one stamen removed; *Leutert* 41; I, fruit variation, all fruits topped by persistent style (x5) a, *Cowie* 2452, b, *Dunlop* 9689, c, *Devitt* 145.



Notes

Possibly not distinct from *T. pentandra*, but the lack of any mature fruits means that this cannot be confirmed. Mature fruits are possibly lacking because they have already been covered by soil and break off on collection of the plant. There are a number of tiny immature pyramidal fruits present on the end of thickened pedicels which are glabrous at their apex, but only a single curved mericarp (on *Keighery 2630*) has developed in any of the fruits which have developed further. Unlike other species, the styles on the apex of the fruits are quite filiform and apparently play no part in the mature fruit. This particular taxon may well have its fruits pushed into the soil, aided by the thickened pedicel.

A single specimen (*Mitchell & Handasyde 2099*) allocated to *T. bicolor* because of its leaflet shape and stamen number has fruits similar to those of this taxon; they are likewise topped by a slender filiform style.

Distinguishing features

Part of the *T. pentandra* complex but distinct from that species by the filiform deciduous style and the development of only a single fruitlet with a curved and unornamented dorsal wall.

Specimens examined

WESTERN AUSTRALIA: Mitchell Plateau: C. 26 km N of mining Camp, *K.F. Kenneally 7935* (CANB, PERTH); 1.5 km SE of mining campsite, *K.F. Kenneally 7858* (PERTH); 5 km NE Amax Camp, *G.J. Keighery 2630* (PERTH).

3. *Tribulopsis* aff. *pentandra* (Koolan Island)

Prostrate, annual *herb*, stems to 50 cm long, usually with appressed hairs often below spreading white hairs. *Leaves* with 2 pairs of leaflets, the lower pair inserted well above stem; leaflets narrowly elliptic, shortly petiolulate, oblique, narrowly acute, subglabrous adaxially (upper), white appressed hairs abaxially (lower), upper pair +/- erect, to 16 mm long, 4.5 mm wide, lower pair smaller, spreading. Flowering *pedicel* 2.5–4 mm long, upright, fruiting pedicel 3–6.5 mm long, deflexed. *Sepals* c. 3 mm long, glabrous adaxially (inner), white-appressed hairs abaxially (outer); margin hyaline. *Petals* yellow throughout, obovate, winged at base, 3–4 mm long, longer than sepals. Extra-staminal glands 5, intrastaminal glands absent. *Stamens* 6–7, all fertile, 5 longer episealous and 1–2 shorter epipetalous, at maturity equal to stigma; filaments c. 1.5–1.8 mm long; anthers 0.2–0.3 mm long. *Ovary* appressed white pubescent, 5-lobed, impressed and glabrous at base at point of insertion of stamens; style (including stigma) 1.5–2 mm long. *Fruit* shortly pubescent, of 1–3, tardily dissociating, fully developed mericarps, each 3.5 mm high, dorsally rounded and reticulately-patterned, unarmed or with paired median and basal outgrowths. Fig. 1, D.

Known only from Koolan and Sunday Islands in the Buccaneer Archipelago of the Kimberleys of W.A., with a possible further collection from One Arm Point on the adjacent mainland. Occurs in sandstone with the One Arm Point collection coming from "red pindan country over rocky sandstone" and the Sunday Island collection from "skeletal sand amongst sandstone gorges". Flowers are present on all 3 collections which were made in March and June.

Distinguishing features

The relationships of this taxon are obviously with *T. pentandra* but the rounded dorsal wall of the fruit with its reticulate markings are so different (compare Fig. 1, C & D) that it has been highlighted here to promote further collecting.

Specimens examined

WESTERN AUSTRALIA: Koolan Island, western end, on road to waterfall, SW of Jap Bay, *P.A.Fryxell*, *L.A.Craven* & *J.McD.Stewart* 4612 (CANB); Sunday Island, Buccaneer Archipelago, *K.F.Kenneally* 8278 (PERTH).

Specimen probably belonging to this taxon: 6 km NW of One Arm Point, W of Whimbrel Point, Dampier Peninsula, *B.J.Carter* 617 (BRI, DNA, CANB, PERTH).

4. *Tribulopsis bicolor* F. Muell. (as “*Tribulopsis*”) *Fragm.* 1: 47 (1858); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 675 (1992); – *Tribulus bicolor* (F. Muell.) F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862); Ewart & Davies, *Fl. N. Terr.* 155 (1917); – *Kallstroemia bicolor* (F. Muell.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 8(1890).

Type citation: Ad flumen Victoriae in campis subarenosis, *F. Mueller s.n.*

Lectotype here designated: Sandy Island, salt water beach, Victoria River, Oct. 1855, *F. Mueller s.n.* (MEL s.n.); *isolectotypes:* K(herb. Hooker - 2 sheets, seen as photographs in Eichler collection of protologues), MEL110979 (herb.Sonder), NSW145424.

Distribution & ecology

Occurs in stony skeletal soils ranging from basalts to shale, often in tussock grasslands or on roadsides. Found from southern Kimberleys through to Victoria River, with single outlier populations in Keep River, Katherine and the McArthur River areas. Flowers and fruits March to June. Fig. 2, I–K.

Typification

Mueller originally intended to use “*T. anisanthera*” as the name for this species; it appears on the MEL sheet as well as the two K sheets.

Notes

Stamen number is usually 10 total, but up to 6 of these (rarely 10 - see next note) stamens can possess longer linear anthers which appear to be non functional or staminodal. These non functional anthers are more likely to be found on the shorter episepalous whorl.

Collections made in August and September from Victoria River Downs (*Robinson R881* from DNA) and Humbert River (*P.Brocklehurst* 370 and *M.O.Parker* 1030, both from DNA) possess flowers and fruits but the distance between leaflets is much reduced and the plants are apparently more compact and fleshy; apart from this, they agree with *T. bicolor*, except that they may be short-lived perennials.

Distinguishing features

Often a distinctive species in the field since it is the only one to have a darker coloured centre to the flower, but this information is not usually available for dried specimens. Nor do all flowers have a darker centre and in the absence of this character it is often difficult to distinguish *T. bicolor* from the other species with 3 leaflet pairs, particularly *T. solandri* (the two are possibly not deserving of separate species status). Differences include the smaller obovate leaflets of *T. bicolor* (6–9.5 mm long) compared with the elliptic to obovate leaflets up to 18 mm in *T. solandri*, and all 10 stamens being fertile in *T. solandri* whereas up to 6 may be staminodal (long linear anthers) in *T. bicolor*.

Selected specimens examined

NORTHERN TERRITORY: 27.6 km NE of Cape Crawford roadhouse on Borroloola road, *K.L. Wilson 5316* (CANB, NSW); 26 km E Victoria River Crossing, *C.R. Dunlop 6904* (CANB, DNA, MEL, MO, PERTH); Keep River area, *R. Roos s.n.* (DNA7361).

WESTERN AUSTRALIA: Kelly Bore, c. 25 km E of Ord River H.S., *Hj. Eichler 22387* (AD, CANB, CHR, LAE, L, NSW, PERTH); Gogo Stn, on the road to Quonbon, *A.A. Mitchell & T. Handasyde 2099* (BROOME, CANB, PERTH).

5. *Tribulopsis sessilis* (Domin)H. Eichler, *Nuytsia* 5: 177(1984); Lawrence, *Fl. Kimberley Region* 677 (1992); Basionym: *Tribulus solandri* var. *sessilis* Domin, *Biblioth. Bot.* 89: 281 (1926).

Type collections: Nordwest-Queensland: Grassflachen der Rolling Downs zwischen Richmond und Cloncurry, Feb. 1910, *K.Domin 5504* (PR p.p.); Nord- Australien: Victoria River, Dec. 1865, *F.Mueller s.n.* (PR p.p., K).

An apparently rare species known only from the Kimberley region, from Liveringa, Brooking Springs and Kununurra, through to Victoria River in the Northern Territory. There is a single modern collection from the Julia Creek region of Queensland, and one of the types also comes from this area. Occurs in alluvial silts, or black or grey cracking clay, frequently with *Acacia farnesiana*. Flowers Dec. to April. Fig. 2, A–C.

Distinguishing features

Distinct from the other species of *Tribulopsis* with 4–5 pairs of leaflets by the lowest pair of leaflets inserted very close to stem and by its glabrous ovary and fruits. Its occurrence on heavy soils may also aid in its recognition.

Specimens examined

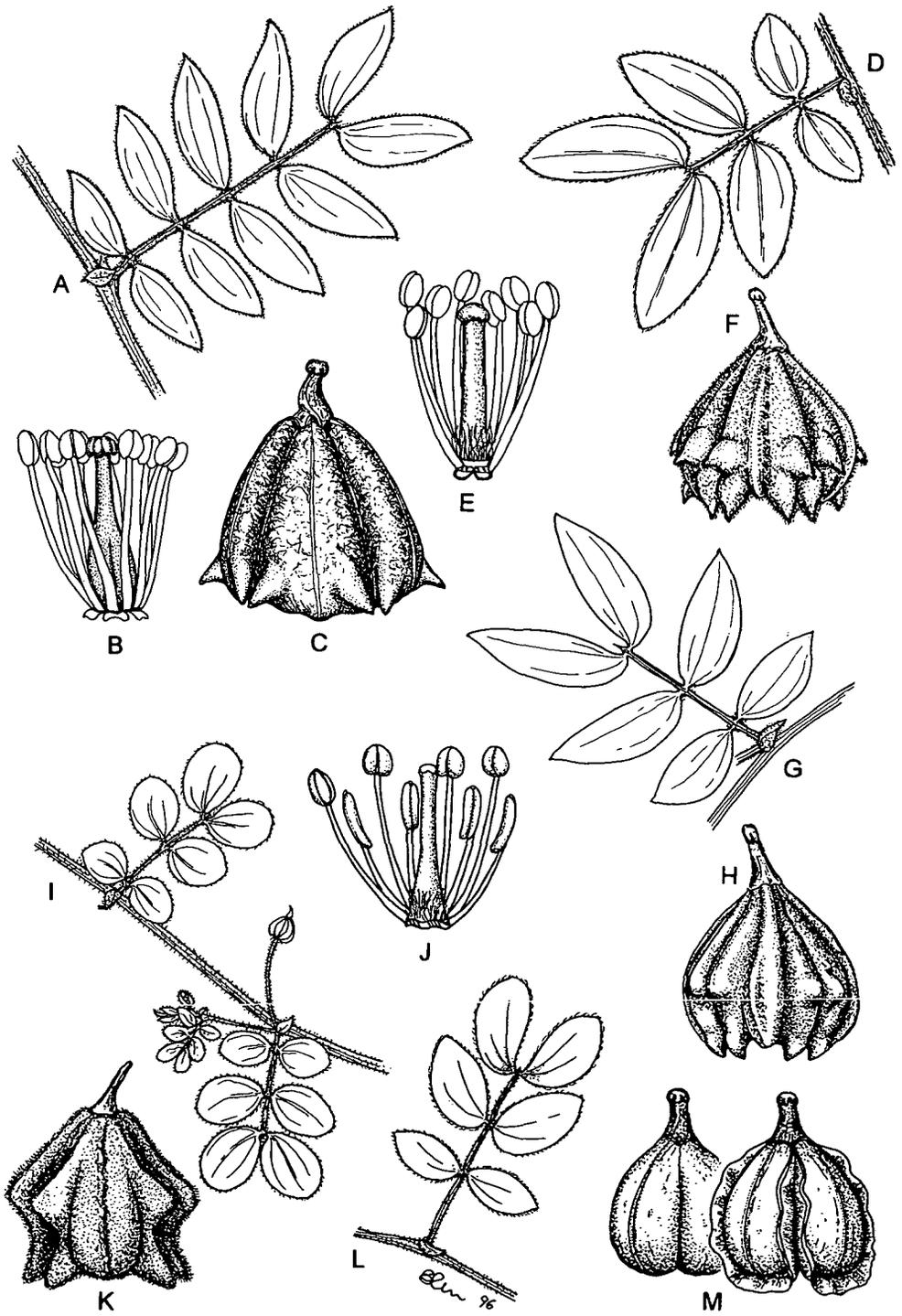
WESTERN AUSTRALIA: Camballin, *J.H. Wickett s.n.* (PERTH); Liveringa, *H.F. Broadbent 592* (PERTH); Carlton Hill Stn, *C. Glover B7-1* (PERTH); Brooking Springs Stn, c. 10 km NE of Fitzroy Crossing, *T.E.H. Aplin et al. 242* (CANB); Kimberley Research Stn, North Bank Diversion Dam, *K.T. Richards 56* (CANB); Carlton Hill Stn near site B7, *C. Glover 142* (CANB).

NORTHERN TERRITORY: 26 km NW of Top Springs roadhouse on Victoria River Downs road, *K.L. Wilson 4751* (NSW).

QUEENSLAND: Cremona Downs Stn, 70 km N of Julia Creek, ii.1989, *A.R. Bird s.n.* (BRI).

6. *Tribulopsis angustifolia* R. Br. in Sturt, *Expedition into Central Australia* 2 App. 70 (1849); H. Eichler, *Fl. Central Austral.* 184 (1981); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 676 (1992); – *Kallstroemia angustifolia* (R. Br.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 88 (1890); – *Tribulus angustifolius* (R. Br.) Benth., *Fl. Austral.* 1: 290 (30 May 1863); Ewart & Davies, *Fl. N. Terr.* 155–156 (1917); Domin, *Biblioth. Bot.* 89: 281 (1926); Specht & Mountford, *Rec. Amer.-Austral. Scientific Exp. Arnhem Land* 247 (1958).

Fig. 2. A–C, *Tribulopsis sessilis*, A, leaf (×2), *Glover B7-1*; B, flower (×10) with petals removed, showing extrastaminal glands, C, fruit, topped by remnant style (×6), both *Broadbent 592*. D–F, *T. solandri*, D, leaf (×2), E, flower (×8) with petals and one stamen removed, both *Morton 558*; F, fruit, topped by remnant style (×8), *S.T. Blake 23485*; G–H, *T. sp. nov Lizard Island*, G, leaf (×2), *Batianoff 12123*; H, fruit, topped by remnant style (×8), *Fisher & Leckie 105*; I–K, *T. bicolor*, I, leaf (×2); J, flower (×10) with petals and two stamens removed, both *Solomon 697*; K, fruit, topped by persistent style (×8) *Evans 3068*; L–M, *T. homalococca* var. *altifer*, L, leaf (×2), M, fruit, topped by persistent style (×10), both *Wilson 8090*, back fruit var. *homalococca*, after illustration in Domin protologue



Lectotype here designated: R. Brown 36 [J.J.Bennett number 5218], 17–28 Nov. 1802, Island a [Sweers Island], Carpentaria (BM); isolectotypes: K, NSW391138, MEL.

Tribulus angustifolius var. *clementii* Domin, *Biblioth. Bot.* 89: 281 (1926).

Type citation: Northwest-Australien: zwischen Ashburton - und Yule River, *E. Clement*.

Probable holotype: N.W. Australia, fl. Ashburton et Yule River, s.dat., *E.Clement s.n.* (PR); isotype: K. Both specimens seen in Eichler MS as photographs.

Tribulopsis affinis (W. Fitzg.) H. Eichler, *Nuytsia* 5: 177 (24 Oct. 1984); – *Tribulus affinis* W. Fitzg., *J. Proc. Royal Soc. W. Austral.* 3: 157 (1918).

Type citation: Near Derby; Lennard, Barker and King Rivers, *W.V.Fitzgerald*.

Syntypes: Junction of Lennard and Barker Rivers, May 1905, *W.V.Fitzgerald 554* (PERTH, NSW145427); Lennard River, May 1905, *W.V.Fitzgerald 554* (NSW145428); King River, East Kimberley, Oct. 1906, *W.V.Fitzgerald 1681* (PERTH, NSW145429, NSW145430 (NSW specimens lacking Fitzgerald number)).

Tribulopsis curvicarpa (W. Fitzg.) Keighery, *Flora* 172: 332 (1982); Hj. Eichler, *Nuytsia* 5: 177 (1984), *superfluous combination*.

Kallstroemia curvicarpus (W. Fitzg.) C.Gardner ex Beard, *Descr. Cat. W. Australian Plants* (1965) 53 *nom. inval.* (no full and direct reference to the basionym); – *Tribulus curvicarpus* W. Fitzg., *J. Proc. Royal Soc. W. Austral.* 3: 158 (1918).

Types: Goody Goody, near Derby, *W.V.Fitzgerald 211* (NSW145425, PERTH).

Tribulus leptophyllus F.M. Bailey, *Old Dept Agric. & Stock. Botany Bull.* 3: 8 (May 1891).

Types: Walsh River, *T.Barclay Miller s.n.* (BM, BRI, K, MEL, all seen in Eichler MS and all apparently annotated by Bailey).

Tribulop[s]is solandri auct non R. Br.: F. Muell., *Fragm.* 1: 47 (1858) p.p. (only as to specimens assigned to *T. angustifolia*); F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862) p.p.; Ewart & Davies, *Fl. N. Terr.* 155–156 (1917).

The most widespread of all of the species being found in all three states of northern Australia, but occurring as far south as the Tropic of Capricorn in all of these states. Occurs in sand or sand/clay in a variety of habitats including tussock grassland, Eucalyptus woodlands, levee banks and red sand interdune areas associated with spinifex. It is often recorded after fire. Fig. 1, G–I.

Notes

A very variable species with respect to hair covering, flower size, ornamentation of the cocci, length of the style, size of the fruit and the number of spines on the fruit; this variation is possibly related to the variety of habitats which it occupies. Larger flowered specimens, which appear to be short-lived perennials because of the possession of a tap root are usually found in beach localities or deep sands of the north coast and in the areas north of Katherine; their fruits are often without any spines. Specimens with both median and basal spines are usually to be found in the more southerly part of the distribution. However these differences were not found to be classifiable since there were many specimens showing variation in flower size and presence or absence of spines on the fruit of the one plant. Any future analysis of the variation of this species should also include *T. aff. angustifolia* (Mt. Isa) since it may also belong here.

Previous species recognised within this complex, *T. leptophyllus*, *T. affinis* and *T. curvicarpa*, are defined by characters which are extremely variable and the species have not been distinguished here.

- *Tribulopsis curvicarpa* applies to specimens with bristly hairs, 4–5 leaflets and the fruitlets hirsute and reticulate on the dorsal surface and with median and basal spines. The name, as has been pointed out by Lawrence (*Flora of the Kimberley Region* p. 676), refers to the curved fruit which develops in all specimens when all but one of the cocci are aborted.
- *Tribulopsis affinis* applies to hirsute specimens with 2–5 leaflets, petals shorter than the sepals and the fruitlets prominently reticulate dorsally and lacking any spines. The character of the petals being shorter than the sepals is erroneous for those

syntypes seen but in some other specimens (e.g. *J. Egan* 1890 from DNA) there are mature buds which have split open, revealing the stamens and very short petals; it is difficult to decide whether these are cleistogamous, since some pollen appears to be mature, or whether they will develop into larger flowers.

- *Tribulus leptophyllus* applies to specimens with 2–3 leaflet pairs, small flowers (petals c. 5 mm long) and only half of the stamens with fertile anthers.

Latz & Albrecht (*Latz 11901*) recorded thousands of fruitlets covering a meat-ant nest after fire. Presumably the seeds or the enveloping coat of the fruitlet must produce some attractant to ants.

Distinguishing features

Usually easily distinguishable from any other *Tribulopsis* species by the linear to narrowly elliptic leaflets (10–45 mm long), the lowest pair of these inserted well above the stem. Those specimens of *T. angustifolia* where the leaflet number is occasionally reduced to 2, compared with the more usual 4–5, can be distinguished from the *T. pentandra* group (also characterised by narrowly elliptic leaflets) by the 10 fertile stamens in comparison with the 5–7 of the *T. pentandra* group and the more rounded and larger (5–11 mm high) fruits of *T. angustifolia* compared with the distinctly triangular and smaller (up to 4 mm high) fruits of *T. pentandra*.

Selected specimens examined

WESTERN AUSTRALIA: Bobby Creek, 11 km ENE of Beagle Bay, Dampier Pen., W. Kimberley, *B.J. Carter 511* (BRI, PERTH); Hidden Valley, just N of Kununurra, *Hj. Eichler 22483* (AD, CANB, CHR, CONC, LAE, L, MO, MEL, NSW, PERTH, P); Bull Creek, Bungle Bungle N.P., *I.D. Cowie 820* (DNA); 5 miles N of Christmas Creek on RPF [Rabbit Proof Fence], *R.D. Royce 1740* (PERTH); 32 km NW of Goldsworthy, c. 4 km along Great Northern Hwy - Shellborough track, *I.R. Telford 6497* & *G. Butler* (CANB).

NORTHERN TERRITORY: Victoria Hwy, Gregory N.P., *I.R. Cowie 2452* & *Brocklehurst* (DNA, CANB, PERTH, MEL); Cape Arnhem, *C.R. Dunlop 9689* & *Wightman* (DNA); Barkly Hwy, *J. Egan 1890* (DNA); Gove; N of Gwupalina Pt, *J. Egan 2750* (DNA); Fiddlers Lake, Tanami Desert, *P. Latz 11901* (MEL, NT); 108.5 km E of Kintore T/off on main Kintore - Papunya Road, Plot 1194, *G. Leach* & *MB 1544* (DNA); Calvert River Mouth, *B.G. Thomson 1853* (DNA).

QUEENSLAND: Near junction of Nassau R and Rocky Creek, *V.J. Neldner 3031* & *J. Clarkson* (BRI, DNA, MBA, PERTH); Near source of Poison Creek, c. 90 miles N of Hughenden, *S.T. Blake 8529* (BRI); Delta South Station, between Barcardine and Blackall, *L.S. Smith* & *S.L. Everist 235* (BRI); 10 km W of Carlo HS, Gregory North District, *C. Mitchell 687* (BRI); 12.5 km NNE of Bowie, on road to Yarrowmere, *E.J. Thompson BUC306* & *B.K. Simon* (BRI); 24 km W of Charters Towers on Hughenden Rd, *K.L. Wilson 5598* (CANB, NSW).

7. *Tribulopsis* aff. *angustifolia* (Mt. Isa)

Prostrate, slender annual herb; stems 20–60 cm long, appressed-pubescent. Leaves with 4–5 pairs of leaflets, the lowest pair inserted well above stem; leaflets narrowly ovate, shortly petiolulate, oblique, shortly acuminate, ciliate, glabrous adaxially, sparsely appressed pubescent abaxially (lower); upper pair erect, 6–10 mm long, 2–3.5 mm wide; lower pairs spreading, similar size. Flowering pedicel 13–24 mm long, upright, fruiting pedicel to 35 mm long, deflexed. Sepals c. 3.5 mm long, glabrous adaxially, sparsely appressed abaxially; margin hyaline. Petals yellow throughout, obovate, 5–7.5 mm long, longer than sepals. Extra-staminal glands 5, intrastaminal glands lacking. Stamens 10, 5 usually shorter, all fertile, at maturity equal to stigma; filaments c. 2 mm long; anthers 0.6–0.8 mm long. Ovary with dense appressed white hairs, 5-lobed; style (including stigma) 1.5–1.8 mm long. Fruit appressed pubescent, of 5, tardily dissociating, fully developed mericarps, each 5–6 mm high, dorsally smooth, with pair of retrorse basal spines and pair of median spines.

Known only by 2 collections from just north of Mt Isa, one from quartzite with *Lophostemon grandiflorus*, the other from scree slopes. Flowering Jan-May.

Distinguishing features

This taxon may represent part of the variation of *T. angustifolia* and further collections may not support its status. However it is distinct from *T. angustifolia* by the hair covering on the ovary, the wider leaflets (almost ovate since the ratio of length to breadth is usually just less than 3:1) and the shorter style.

Specimens examined

QUEENSLAND: 13 km NE of Mt Isa, P.L. Harris 460 (BRI); Lake Moondarra, NNE of Mt Isa, K.L. Wilson 5429 (CANB, NSW- 2 sheets).

8. *Tribulopsis solandri* R. Br. in Sturt, *Expedition into Central Australia 2 App.* 70 (1849); F. Muell., *Fragm.* 1: 47 (1858) p.p. (excluding specimens assigned to *T. angustifolia*); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 678 (1992); – *Tribulus solandri* (R. Br.) F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862); Benth., *Fl. Austral.* 1: 290 (1863); F. Muell. *Fragm.* 11: 30 (1878); F.M. Bailey, *Queensl. Fl.* 1: 173 (1899); Domin, *Biblioth. Bot.* 89: 281 (1926); – *Tribulus solandri* var. *typicus* Domin, *Biblioth. Bot.* 89: 281 (1926); – *Kallstroemia solandri* (R. Br.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 88 (1890).

Type collections: In ora orientali intratropica Novae Hollandiae prope Endeavour River, 1770, J.Banks & D.Solander s.n. (BM, BRI (ex BM), NSW133284 (ex BM) - all seen as photographs in Eichler collection of protologues. Specimens are annotated as “*Tribulus minor* Sol.”).

Found only on Cape York Peninsula. Occurs in sands, associated with beaches and rivers, and also in basalt and granite. Flowering March to May. Fig. 2, D–F.

Notes

The name applies to the slender herb found in the sands of the Cook region of Queensland. More robust specimens from Western Australia which have been included within the species in the past approach *T. bicolor* more closely and indicate a much closer relationship to that species than the present taxonomy indicates. From a study of the specimens it seems likely that *T. bicolor* should perhaps be included under *T. solandri* but the two have been maintained here since they have not been seen in the field and there are possibly other characters to be found.

The darker centre of the flower of *T. bicolor* is not to be found in all specimens and in any case cannot be recognised on dry material; the tendency for the ovary of *T. bicolor* to be glabrous and clearly seated upon a ring of nectariferous tissue breaks down in some specimens where the ovary is sparsely to densely white pubescent, with the hairs appressed or erect. In these specimens it is difficult to make out what is happening with the nectariferous tissue, although in *T. solandri* the tissue seems to be present as 5 distinct glands. The hairs on the ovary of *T. solandri* are finer and apparently in 5 bundles compared with the stiff, erect hairs of some of the Western Australian specimens.

Mueller (1878) included *T. angustifolia* within *T. solandri*.

Distinguishing features

Within the groups of species which have 3 leaflet pairs, *T. solandri* can be distinguished from *T. homalococca* by its paired basal and median outgrowths on the fruit (lacking in *T.*

homalococca) and from *T. bicolor* by its elliptic to obovate leaflets up to 18 mm long (cf. 6–9.5 mm long in *T. bicolor*) and by its 10 fertile stamens whereas up to 6 may be staminodal (long linear anthers) in *T. bicolor*. However *T. solandri* and *T. bicolor* (q.v.) may prove not to be sufficiently distinct to both warrant species status.

Specimens examined

QUEENSLAND: Quarantine Bay near Cooktown, *S.T. Blake 23485* (BRI); Twelve Mile Lagoon area, Lakefield N.P., *A.R. Bean 5528 & P. Forster* (BRI, CANB); Weipa, Nanam Beach on Mission River, *A. Morton 558* (BRI).

9. *Tribulopsis* aff. *solandri* (Lizard Island)

Prostrate, slender annual herb; stems 20–60 cm long, usually glabrous, sometimes with appressed, curled white hairs in young parts. Leaves with 3 pairs of leaflets, the lowest pair clearly petiolate; leaflets ovate or obovate, shortly petiolulate, oblique, acute or shortly acuminate, glabrous adaxially and abaxially (lower), upper pair suberect, lower spreading, to 11 mm long, to 5.5 mm wide, lowest pair smaller. Flowering pedicel 3.5–6 mm long, upright, fruiting pedicel 7–15 mm long, deflexed. Sepals 2.6–3.4 mm long, glabrous adaxially(inner), sparsely white-appressed abaxially (outer); margin hyaline. Petals yellow throughout, obovate, 5.5–6(–8.4) mm long, longer than sepals. Extra-staminal glands 5, intrastaminal glands 5 or sinuate ring. Stamens 10, all fertile or up to 6 staminodal, at maturity equal to stigma; filaments 1.8–2.5(–3) mm long; anthers 0.4–0.7 mm long if fertile, 1.1–1.5 mm long if staminodal. Ovary glabrous, ?not seated on intrastaminal ring; style (including stigma) 1.5–2 mm long. Fruit glabrous, of 4–5, tardily dissociating, fully developed mericarps, each 3–3.5 mm high, with pair of divergent median and retrorse basal bumps dorsally. Fig. 2, G–H.

Restricted to Lizard and Flinders Islands off the coast of Cape Yorke Peninsula. Occurs in coastal sands, usually amongst grasses such as *Cyperus* and *Schizachyrium* below *Casuarina equisetifolia*. Flowers April–Aug.

Distinguishing features

Possibly only a glabrous form of *T. solandri*, except that the pedicels tend to be shorter and the dorsal surface of the fruit is more rounded and only develops bumps medianally and basally, rather than spines. Further collections and field work are needed to clarify its status.

Specimens examined

QUEENSLAND: Lizard Island, Casuarina Beach, *G.N. Batianoff 12123* (BRI, CANB, DNA, BISH, K, NSW); Flinders Island, c. 7 km N of Bathurst Head in southern end of Princess Charlotte Bay, *J.R. Clarkson 2267* (BRI); Flinders Island, *J.A. Elsol 753 & T.D. Stanley* (BRI); Lizard Island, *N. Byrnes 3142* (BRI); Lizard Island, N end of Research Beach, *N. Fisher 105 & H. Leckie* (CANB).

10. *Tribulopsis homalococca* (Domin)R.M. Barker, *comb. nov.*

Tribulus homalococcus Domin, *Biblioth. Bot.* 89: 280 (1926), t. 37, fig. 2–5.

Syntypes: *K.Domin 5503*, Feb.1910, in collibus calcareis apud opp. Chillagoe (PR); *K.Domin 5502*, Feb.1910, in collibus calcareis Lions Head Bluff dictis apud opp. Chillagoe (PR) – seen as photographs in Eichler collection of protologues.

Both varieties of *T. homalococca* have only been collected from the Chillagoe area of Queensland. Fig. 2, L–M.

Further collections of this species are desirable to attain an understanding of its variability and relationship to other species of *Tribulopsis* and any collectors who find themselves in the Chillagoe area in February–March are requested to look out for this

species. The illustrations accompanying the type descriptions (see synonymy above) should prove helpful to anyone searching for the species.

Distinguishing features

T. homalococcus can be distinguished amongst the species with 3 pairs of ovate to obovate leaflets by the appressed, curled white hairs in young parts, by the glabrous ovary and by its dorsally rounded fruits lacking any outgrowths, except a basal semicircular wing in the case of var. *alifer*.

Key to varieties of *T. homalococca*

Mericarps lacking wings, glabrous a. var. *homalococca*
 Mericarps with basal semicircular wings, covered with short erect pubescence b. var. *alifer*

10a. *Tribulopsis homalococca* Domin var. *homalococca*

Tribulus homalococcus var. *typicus* Domin, *Biblioth. Bot.* 89: 280 (Oct. 1926) *nom. inval.* (type variety).

Fruit rounded dorsally, lacking wings, spines or any outgrowths, glabrous.

As stated above, the only collection known is that of the type from the Chillagoe area.

Specimens examined

None seen. The Hubbard & Winders collection cited below may belong here since it does not possess mature fruit, but there are indications on the young fruits that the wing characteristic of var. *alifer* is developing.

Distinguishing features

The fruits of *Tribulopsis homalococca* var. *homalococca* would appear to be unique in the genus by their lack of any outgrowths and their rounded smooth nature.

No authentic specimens of *Tribulopsis homalococca* var. *homalococca* have been seen except the type, and even these, only as photographs in the Eichler manuscripts.

10b. *Tribulopsis homalococca* var. *alifer* (Domin)R.M. Barker, *comb. nov.*

Tribulus homalococcus var. *alifer* Domin, *Biblioth. Bot.* 89: 280 (1926) t. 37, fig. 6.

Holotype: Bei Chillagoe, Feb. 1910, *K. Domin 5501* (PR), seen as photograph in Eichler collection of protologues.

Fruit rounded dorsally, with basal semicircular wing on each of the fruitlets, covered with short dense erect fine pubescence. Fig. 2, L-M.

Known only from the Chillagoe area of North Queensland. Occurs on lower open slopes of limestone bluffs within grasses in open Eucalyptus forest. Flowers Jan.-Feb.

Wilson's notes on her collection indicate that the fruits of this taxon were pale pink and somewhat fleshy.

The Hubbard & Winders collection of this taxon was annotated by Eichler with the name *Tribulopsis homalococca* (Domin)H. Eichler, indicating that he intended to make this combination.

Distinguishing features

As for *T. homalococca* but each fruitlet has a wing along the boundary of the dorsal and lateral walls.

Specimens examined

QUEENSLAND: Chillagoe, C.E. Hubbard & C.W. Winders 6751 (BRI, K); 2 km along Royal Arch road from Gulf Development Rd (W of Chillagoe), K.L. Wilson 8090, J. Clarkson & S. Jacobs (BRI, NSW)

Acknowledgments

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Denzel Murfet made a special effort to collect *Tribulopsis* while based at Borroloola in the Northern Territory and I am indebted to him for his comments on the dispersal of the fruitlets.

Bibliography

- Barker, R.M. (1996). New taxa, new combinations, keys and comments on generic concepts of *Zygophyllum* and a new species of *Tribulus* (Zygophyllaceae) in the manuscripts of the late H.J. Eichler. *J. Adelaide Bot. Gard.* 17: 161–172.
- Barker, R.M. (1998). A trial key and notes on *Tribulus* (Zygophyllaceae) in Australia, including one new species and validation of *Tribulus suberosus*. *Nuytsia* 12(1): 9–35.
- Beard, J.S. (1965). *Descriptive Catalogue of West Australian Plants*. 1st ed. (Surrey Beatty & Sons: Chipping Norton).
- Benthams, G. & Hooker, J.D. (1862). *Tribulus*. In *Genera Plantarum* 1: 264 (A.Black: London).
- Benthams, G. (1863) Zygophyllaceae. In *Flora Australiensis* 1: 286–294 (Lovell, Reeve & Co.: London).
- Brown, R. (1849). Appendix In C. Sturt, *Narrative of an expedition into Central Australia...during the years 1844, 5 and 6*. (Smith, Elder & Co.: London)
- Burbidge, N.T. (1963). *Dictionary of Australian Plant Genera*. (Angus & Robertson: Sydney).
- Eichler, H. (1984). New combinations in *Tribulopsis* (Zygophyllaceae) of the Western Australian flora. *Nuytsia* 5: 187.
- Engler, H.G.A. & Prantl, K.A.E. (1890). Zygophyllaceae. In *Die Natürlichen Pflanzenfamilien* 3(4): 74–88. (Engelmann: Leipzig).
- Green, J. (1985). *Census of the vascular plants of Western Australia*. 2nd ed. (Western Australian Herbarium: Perth).
- Hnatiuk, R. (1990). *Census of Australian Vascular Plants*. Australian Flora and Fauna series no. 11. (AGPS: Canberra).
- Keighery, G. (1982). Geocarpy in *Tribulopsis* R. Br. (Zygophyllaceae). *Flora* 172: 329–333
- Lawrence, M. (1992). *Tribulopsis*. In J. Wheeler (ed.) *Flora of the Kimberley Region*. 675–678 (Conservation and Land Management, Como).
- Mueller, F. (1858). *Fragmenta Phytographiae Australiae* 1: 47 (John Ferres, Govt Printer: Melbourne).
- Mueller, F. (1862). *Plants Indigenous to the Colony of Victoria*. vol. 1: 99 (John Ferres, Govt Printer: Melbourne).
- Mueller, F. (1878) *Fragmenta Phytographiae Australiae* 11: 30 (John Ferres: Govt Printer: Melbourne).
- Porter, D.M. (1969). The genus *Kallstroemia* (Zygophyllaceae). *Contrib. Gray Herb. Harvard* 198: 41–153.
- Porter, D.M. (1972). The genera of Zygophyllaceae in the southeastern United States. *J. Arn. Arb.* 53: 532.
- Sheahan, M.C. & Chase, M.W. (1996). A phylogenetic analysis of Zygophyllaceae R. Br. based on morphological, anatomical and *rbcL* DNA sequence data. *Bot. J. Linn. Soc.* 122: 279–300.

