

A revision of the tiurndins (*Tribonanthes*, Haemodoraceae)

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Abstract

Hickman, E.J. & Hopper, S.D. A revision of the tiurndins (*Tribonanthes*, Haemodoraceae). *Nuytsia* 30: 87–154 (2019). The tiurndins (*Tribonanthes* Endl.) comprise a small taxonomically challenging genus of geophytes endemic to the Southwest Australian Floristic Region. Six named and one undescribed species of *Tribonanthes* are recognised in recent literature. *Tribonanthes* poses the most difficult taxonomic problems remaining for the Haemodoraceae in Western Australia. It is a genus where herbarium studies alone are insufficient to delineate taxa. A knowledge of variation in wild living material has proved essential to resolve taxonomic difficulties in the tiurndins. This revision recognises and comprehensively illustrates living plants of the 12 recognised species, four of which are new (*T. elongata* E.J.Hickman & Hopper, *T. keigheryi* E.J.Hickman & Hopper, *T. monantha* E.J.Hickman & Hopper and *T. porphyrea* E.J.Hickman & Hopper). *Tribonanthes variabilis* Lindl. and *T. uniflora* Lindl. are reinstated. Morphological and molecular data also support the recognition of three new subgenera: subg. *Tribonanthes*, subg. *Salina* E.J.Hickman & Hopper and subg. *Boya* E.J.Hickman & Hopper. Botanical illustration, especially of internal floral morphology, has revealed several previously unrecorded characters that help diagnose the species of *Tribonanthes*.

Introduction

Tribonanthes Endl. is a small, taxonomically challenging, genus of geophytes comprising some 12 species (this study) placed in Haemodoraceae subfamily Conostylidoideae (Lindl.) T.Macfarlane & Hopper. The genus is endemic to the Southwest Australian Floristic Region (SWAFR, *sensu* Gioia & Hopper 2017). *Tribonanthes* is currently placed in the monotypic Tribe Tribonantheae T.Macfarlane & Hopper, sister to all other members of the Conostylidoideae (Macfarlane & Hopper 1987; Simpson 1990; Hopper *et al.* 1999, 2009; Smith *et al.* 2011). Divergence of *Tribonanthes* has been estimated as occurring in the Eocene about 40 MA, with contemporary species diversifying since 5 MA (Hopper *et al.* 2009).

No common name has been adopted for the genus, except occasionally ‘flannel flowers’, which is confusing as it has been widely taken up for *Actinotus* Labill. in the Apiaceae. There is also no definitive Aboriginal name for members of *Tribonanthes* recorded in the literature or among extant Noongars SDH has interviewed over the past four decades.

Colonial botanist James Drummond (1842a: 4), in a discussion of the SWAFR’s rich Haemodoraceae flora, mentioned a possible name, but left its application in doubt: ‘There are two sorts of round white roots called *Jitta Cara* by the natives, which they sometimes eat; pigs also are fond of them. I cannot

refer these plants with certainty to any described.’ Grey (1840: 54) listed *Jeeta* as ‘the root of a species of rush; this root is something like a grain of Indian corn in appearance and resembles it in taste. It is in season in June.’ Moore (1884: 37) gave *jitta* as meaning ‘the bulbous root of an orchis, eaten by the natives, about the size of a hazel nut’, and *kara* was for ‘a spider’. Some modern Noongars use *Kara* for *Burchardia congesta* Lindl. (Daw *et al.* 1997), with clusters of long slender white corms, but Drummond (1842b: 5) was clear that ‘*carra*’ was applied to the much sought after orchid tuber of *Lyperanthus suaveolens* (= *L. serratus* Lindl.) in Western Australia. These alternative applications render the inferred application of *Kara* to *Tribonanthes* problematic.

Another similarly problematic name is *djoobak* (*djubak, dubak, joobak, jubak, tubac, tuboc*). Historically, this was applied to an edible small yam, usually of an orchid ‘... in season in .. October. The flower is a pretty white blossom, scented like the heliotrope.’ (Moore 1884: 22). Resemblance to a hyacinth was suggested by Grey (1840: 33). Botanist James Drummond (1842b: 5) stated that ‘*Prasophyllum giganteum* produces the roots called ‘*tubac*’ by the natives’. Modern Noongars apply the name to the orchid *Pyrorchis nigricans* (R.Br.) D.L.Jones & M.A.Clem. (Daw *et al.* 1997) but Yued elder Ned Mippy identified as *djoobak* specimens of *Tribonanthes longipetala* near Moora and New Norcia (Rooney 2002: 286). However, subsequently Rooney (2011: 125) gave a more general meaning for *djoobak* as a native potato, an ‘edible kidney-shaped tuber species’, and Wheatbelt Natural Resource Management (n.d.) similarly listed *djubak* as a general term for bush potato. Brandenstein (1988: 115) conveyed that some Esperance Noongars applied *tyubaq* to the tubers of *Platysace effusa* (Turcz.) C.Norman (Apiaceae). It remains difficult to unequivocally apply this name to tubers of *Tribonanthes* species, with the weight of evidence pointing more towards *djoobak* traditionally being a name for a scented, multiflowered (like a hyacinth) edible orchid tuber.

Here, as a mark of respect to the indigenous people of the SWAFR, we propose instead that ‘*tiurndin*’ is an apposite common name for the genus *Tribonanthes*. *Tiurndin* (pronounced churn-din) means ‘fair, white (flowers)’ according to Noongar informants from the Esperance region as recorded by von Brandenstein (1988: 101). Introduced sheep sometimes were also bestowed the same name, indicating that white wool may be regarded as meriting the label *tiurndin*. However, the first use of *tiurndin* was for white flowers, perhaps with a woolly appearance, which commends the name for most species of *Tribonanthes*. *Tiurndin* is derived from *Tyiurtt*, ‘the ancestral hero involved in the creation of the southern coastline’ (von Brandenstein 1988: 113), which is renowned for its brilliant white sand beaches. Indeed, *Tyiurtt*’s name recurs in many forms where the colour white appears on the south coast, as in *chuditch* (white-spotted native cat), Mt *Chudalup* (a granite inselberg bedecked by white lichen), *maartyiurt* (white-pointer shark = hands white-tipped), *tyiurndur* (bright stars), and *Tyiurtigellup* (Lake Seppings at Albany, brilliantly reflecting white light on a still, cloudy day).

At present, six named and one undescribed species of *Tribonanthes* are recognised in contemporary literature (e.g. Parsons & Hopper 2003; Smith *et al.* 2011) and data bases maintained by the Western Australian Herbarium (1998-continuously updated). While some of these taxa are clear-cut, others are polymorphic and difficult to key out with the latest taxonomic treatment, now three decades old (Macfarlane 1987). Indeed, these taxonomic problems were evident to Bentham (1873: 426) who wrote from studies of specimens at the herbarium in Kew that: ‘the species appear to be very variable and difficult to distinguish’.

We are currently involved in a broad study of the Haemodoraceae commenced in the 1970s (see Hopper *et al.* 2009 and references therein). This research soon identified the need to better understand taxonomic variation in *Tribonanthes*. Arguably, following recent resolution of tropical Kimberley *Haemodorum* Sm. species (Barrett *et al.* 2015), *Tribonanthes* poses the most difficult taxonomic

problems remaining for the family in Western Australia, although there remain undescribed taxa in other genera still to be dealt with (Smith *et al.* 2011). Until the alpha-taxonomy of *Tribonanthes* is resolved, molecular phylogenetic and other biological studies will be, and have been, significantly hampered (e.g. Hopper *et al.* 2009), with the need for collecting voucher herbarium specimens for such studies remaining critical. Indeed, the few biological investigations conducted on *Tribonanthes* have been accompanied by the lodgement of few or no vouchers (e.g. Pate & Dixon 1982), rendering their results difficult to ascribe to species today.

We have also been interested in exploring the use of modern techniques of botanical illustration as a means of discovering novel variation (Hickman *et al.* 2017). The contributions of botanical artists in discovery through illustration are rarely explicit in the literature. Here, we set out with the aim of having a botanical illustrator lead the research towards a taxonomic revision, and we make clear below what traits have been discovered through that process. Consequently, this paper focuses on a comprehensively illustrated revision of the genus *Tribonanthes*, with our combined efforts revealing the presence of 12 species, four of which are new and two reinstated.

Taxonomic history

If they were collected, no surviving specimens of *Tribonanthes* persist from the earliest maritime explorations of the SWAFR coastline, despite the genus being common enough around Perth, King George Sound and the Esperance region granites (Hopper 2003, 2004). The earliest scientific specimens extant were collected by Baron Karl A.A. von Huegel during the first 12 days of 1834 when at King George Sound. We know from his field journal that he ascended Mt Clarence on January 5th (Hopper 2004), and that *T. australis* Endl. occurs there today and on other nearby inselbergs such as Mt Melville.

The precise location of Huegel's collection was not documented. Endlicher (in Endlicher & Fenzl 1839) based comprehensive descriptions of the new genus and species on Huegel's collection. No comparison with other genera was made, other than the sequence in which the description appeared, but the diagnostic characters of *Tribonanthes* cited below were well-described. An illustration of *T. australis* was published by Endlicher in 1841 (Endlicher 1837–41) (Figure 1).

James Drummond, who arrived in the Swan River Colony in 1829, undoubtedly was aware of species of *Tribonanthes* well before Huegel. However, Drummond's earliest extant collections were made in 1839, some of which were used by Lindley (1839–40) as type material for *T. brachypetala* Lindl. (CGE 06823) and *T. longipetala* Lindl. (CGE 06824).

Lindley (1839–40) named two other new species – *T. variabilis* Lindl. based on Georgiana Molloy collections from the Vasse River (CGE 23342), and *T. uniflora* Lindl. (CGE 06825) from Captain Mangles' collections (or acquisitions from Drummond and others more likely – Hopper 2004). Lindley offered the rather disparaging comment that the tiurndins 'are plants of no beauty, as far as can be ascertained by their appearance in the form of dried specimens' (Lindley 1839–40: 44). Had he seen living plants, Lindley may have been more impressed by *Tribonanthes*.

Lindley's (1839–40) contribution was the first to reveal diversity amid seeming uniformity among the few herbarium specimens of *Tribonanthes* then available for study in Britain and Europe. This is a genus where herbarium studies alone are insufficient to delineate taxa. Field studies and dissection of living material are essential, we have found, to develop sound taxonomic insights for the tiurndins. Consequently, many herbarium collections have mixed material mounted on the same sheets.

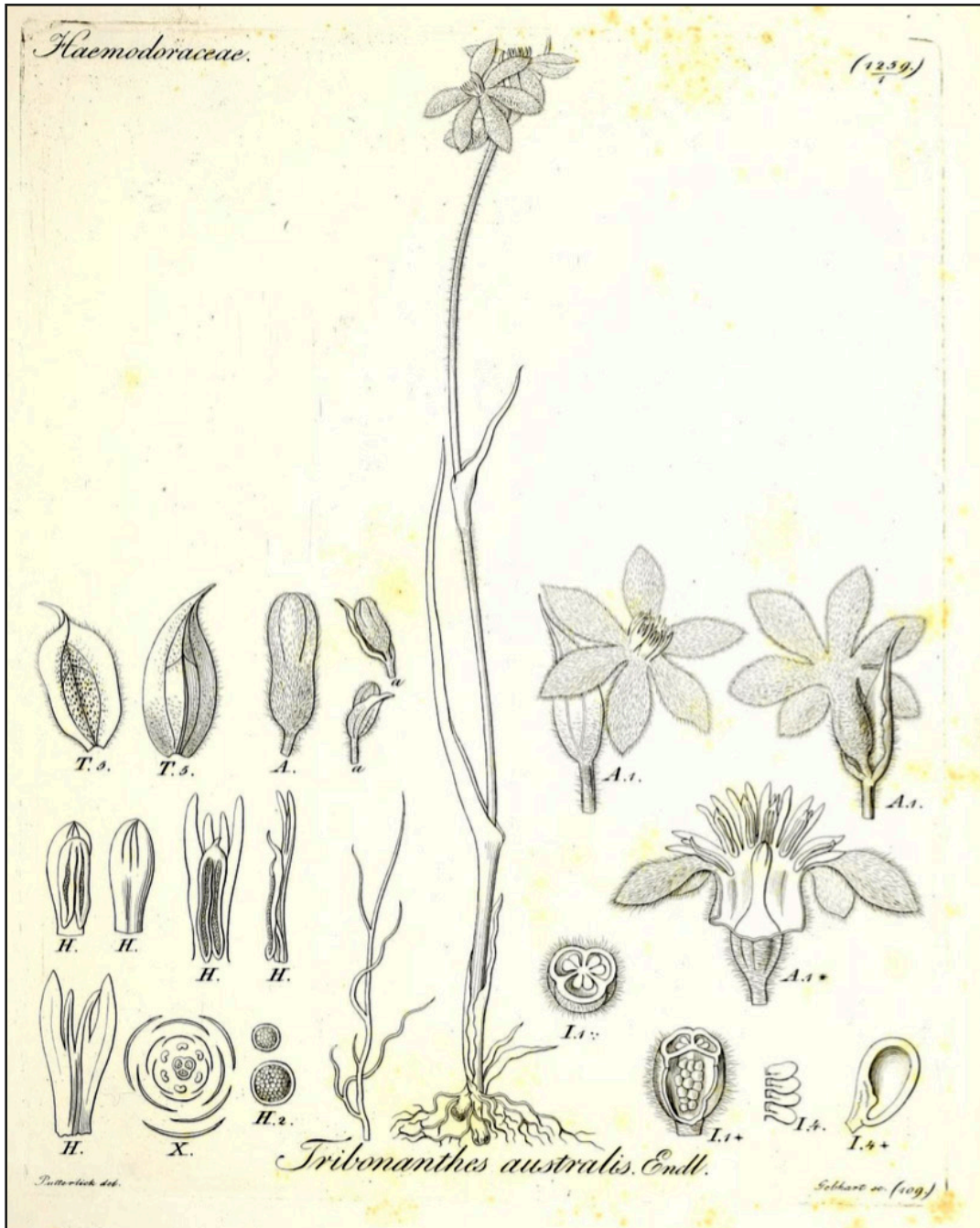


Figure 1. Uncoloured engraving of *Tribonanthes australis* from a drawing of Hügel's King George Sound collection of this species by Putterlick, published by Endlicher in *Iconographia Generum Plantarum* (Endlicher, 1841) (Image from the Biodiversity Heritage Library. Digitised by [Field Museum Natural History Library] <https://www.biodiversitylibrary.org/item/130502#page/235/mode/1up> [accessed 5 May 2016]). This illustration, in its original publication, is the neotype of *T. australis*.

The type sheet of *T. variabilis* (CGE 23342), for example, includes one specimen of *T. longipetala* (second from left). All other specimens on the sheet are *T. variabilis*. Also, sketches of the stamen connective appendages at the bottom of the sheet show a *T. variabilis* stamen connective appendage on the left and a *T. longipetala* stamen connective appendage on the right. Lindley's original description of *T. variabilis*, based on this collection, mentions two length conditions; 'filamentis antherae subaequalibus dentatis v. petaloideis longioribus' (Lindley 1839–40: 44) hence the name *variabilis*, alluding to what Lindley perceived as the variable nature of the stamen connective appendages in this species.

Even more confusing is the type sheet of *T. uniflora* (CGE 08625) which includes three taxa. The single lectotype from Mangles on the left side of the sheet agrees well with Lindley's protologue, notably in having testicular (cormous) roots, the bract and upper leaf with noticeably membranaceous margins, and the anthers and filaments much shortened. On the right hand side, the Molloy collection from 'swamps, The Vasse' (River near Busselton) has the earliest extant representatives of one of the new species we name below as *T. porphyrea* E.J.Hickman & Hopper (if stamen connective appendages are cream), or *T. elongata* E.J.Hickman & Hopper (if stamen connective appendages are yellow). A solitary plant embedded in this collection, second from the right, labelled 'A' and determined in 1984 as *T. violacea* Endl. by T.D. Macfarlane, is another new species collected by Mrs Molloy that we name below as *T. keigheryi* E.J.Hickman & Hopper.

Endlicher (1846) published a new taxon (*T. violacea*, MEL 104289) based on collections of Ludwig Preiss made in October 1840 between Mounts Elphinstone and Melville at King George Sound (Albany). Endlicher erected new names for species already described by Lindley (1839–40) using Preiss specimens from Perth as types, thus creating the synonyms *T. odora* Endl. (= *T. brachypetala*) and *T. lindleyana* Endl. (= *T. longipetala*).

George Maxwell, during or before 1873, on one of his expeditions eastwards from Albany discovered at Cape le Grand more *Tribonanthes violacea* (e.g. K 000356594, incorrectly determined as *T. uniflora*). On this same sheet are two specimens collected by Georgiana Molloy in 1841 at the Vasse River (K 000356593). The left-hand specimen is more of the earliest extant collection of one of the new species we name below as *T. porphyrea* or *T. elongata* while the right-hand specimen is of the slender swamp-dwelling *T. keigheryi*.

Additional complexity on this sheet is evident in a single specimen (K 000356595) collected by Augustus Oldfield in 1873 at the Kalgan River north of Albany. This is correctly determined as *T. uniflora*.

Several such mixed collections were available to Bentham (1873), who correctly used Lindley's (1839–40) four earlier names and effected the relevant synonymies for Endlicher's (1846) later names. Moreover, Bentham, without the benefit of field studies of living material, regarded *T. violacea* as a synonym of *T. uniflora*, and suggested that *T. variabilis* was 'perhaps a variety only of *T. australis*'. Understandably, given the limited and mixed material available to him, Bentham obfuscated as much as clarified the taxonomy of *Tribonanthes*.

Mueller (1872–1874), perhaps at the time unaware of Bentham's (1873) synonymies, supported Endlicher's (1846) *Tribonanthes* species rather than Lindley's (1839–40) which had priority. However, Bentham's (1873) treatment prevailed for close to a century until Geerinck (1969: 65) suggested that *Tribonanthes* had only three, problematic species (i.e. the type *T. australis* and two others not specified). No workers before or since Geerinck (1969) have agreed to such a conservative view of the number of species of tiurndins.

Macfarlane's (1987) *Flora of Australia* treatment, the first by a resident Western Australian botanist, achieved some clarification, although based on decisions informed by limited field work (Macfarlane *pers. comm.* 2014). He recognised four species among the six that Bentham (1873) had listed (*T. australis*, *T. brachypetala*, *T. longipetala*, *T. violacea*), and synonymised two – *T. uniflora* under *T. longipetala*, and *T. variabilis* under *T. australis*.

A year earlier, in 1986, one of us (SDH) with colleagues Sue Patrick and Andrew Brown from the then Department of Conservation and Land Management, had discovered an almost glabrous and stemless pink-flowered new species on a granite outcrop in the central wheatbelt. This was named *T. purpurea* T. Macfarlane & Hopper in the appendix of the *Flora of Australia* volume in which Macfarlane's (1987) treatment of *Tribonanthes* was published. Subsequently, a second striking new species was discovered by SDH (Hopper 6931, PERTH 07438761), accompanied by Stephen van Leeuwen, near Meckering in October 1988. This was a diminutive species, growing barely more than 3–5 cm tall, the smallest of any Haemodoraceae known. Four years later, in 2002, Mike Lyons collected this same undescribed species from near Pingrup and Lake King (Lyons & Keighery 2006), and it was named *T. minor* M. Lyons & Keighery.

Lastly, in 1997 a small-flowered and slender-stemmed taxon in swamps at Lake Muir was recognised as an undescribed species by G.J. Keighery and given the phrase name *Tribonanthes* sp. Lake Muir (G.J. Keighery & N. Gibson 2134). In recent times, then, *Tribonanthes* was regarded as comprising this unnamed species and six described species – *T. australis*, *T. brachypetala*, *T. longipetala*, *T. minor*, *T. purpurea* and *T. violacea*.

Methods

We have examined herbarium specimens of *Tribonanthes*, including types lodged at the Western Australian Herbarium (PERTH), and AD, BM, CANB, CBG, K NSW and MEL. Also images of types and specimens were examined through Global Plants (<http://plants.jstor.org/>) at B, E, L, LD, P, S and W. Opportunistic collections, photography and field notes of *Tribonanthes* were made by SDH since the 1970s during field work in the SWAFR. For this intensive revision, at least five geographically representative populations for each of the six described and one undescribed species were identified by E.J.H. for field visits and collection of fresh material for illustration so that discernible variation within known species was covered. Not all populations were able to be relocated due to limited or incorrect GPS co-ordinate information (often due to retrospective or automated estimation) associated with the herbarium specimens, or historical habitat alteration or deterioration. During searches for target populations, if other *Tribonanthes* species were found, opportunistic collections were taken. A voucher herbarium collection was made for each taxon at each population and lodged at PERTH. Leaf material from specimens at each of the populations visited was collected for subsequent molecular analysis. The results (to be published elsewhere) were taken into account in making our taxonomic decisions.

Colour botanical illustrations of each species we recognised, including variants within species, were made from fresh specimens with or without the aid of a dissecting microscope. Whole plant, details of above ground and below ground parts, including dissections of flowers, capsules, leaves, corms and roots, were illustrated to discover and elucidate morphological character traits.

Measurements of quantitative character traits for each species were taken from dried pressed material (Figure 2). Flowers, inflorescence and floral bracts were removed and rehydrated prior to dissecting and measuring. Inflorescence and floral bracts were splayed out to measure width as shown in Figure

2. Measurements are presented as ranges compiled from specimens of several populations across the distribution of each species.

Descriptive terminology used herein follows that adopted by Simpson (1990, 1998, 2006). Specimens cited are a selection seen. For types, we use an exclamation mark (!) for those seen as specimens, 'image!' for those seen as images online and '*n.v.*' for those not seen.

The species concept applied is both morphological and biological, following that articulated by Hopper and Brown (2001), and first used by Darwin (1868). New species are recognised if they grow in populations (i.e. are not aberrant individuals within populations displaying normal variation), if they have traits or a combination of traits not seen in any previously named species, and especially if they grow with previously named species and produce few or no natural hybrids, the latter exhibiting evidence of partial or full sterility. Ecological data, including habitats occupied, were also determined through field survey and summary of the information provided from herbarium specimens examined. We were unable to conduct experimental tests of reproductive interactions of putative species. However, as an independent test of reproductive isolation, we sequenced DNA from each study population to search for genetic divergence or uniformity, as well as explore molecular phylogenetics.

To highlight discoveries made through illustration, examples are listed within figure captions below.

Distribution maps were compiled on a base phytogeographic map from Gioia and Hopper (2017) showing floristic districts and provinces for the SWAFR. Locations came from label details of specimens held at PERTH and determined by the senior author in line with this taxonomic revision.

Life Cycle and Comparative Morphology

Seedlings (Figure 3). Little has been published on seed biology and germination requirements. However, *T. australis* seed are recorded as germinating on average within 65 days of sowing, ranging from 55 to 103 days (Fryer 2006). Contractile roots of the germinating seedling pull the apex down into the soil soon after germination

Corms and roots. Colourless roots lacking rhizosheaths (Smith *et al.* 2011) are produced in the autumn just above the corms at a depth of 2–5 cm below soil level. Roots are simple (*T. variabilis*) or may have a covering of fine short or long colourless root trichomes, with the long trichomes having some sand-binding ability (*T. minor* and *T. purpurea*). Aerne-Hains and Simpson (2017) described the root anatomy of *T. australis* (? *T. variabilis*). They found the endodermal cell wall of the roots is not thickened. The ground tissue of the central vascular cylinder consists of small isodiametric cells, with thin cell walls. These isodiametric cells have peripheral globular tanniniferous deposits present. The roots have two xylem poles (diarch) with a single large vessel flanked by 10–12 small vessels on either side and only two groups of phloem alternating between the xylem arches. Roots wither during the onset of dry soil in late spring (Pate & Dixon 1982; Figure 3). Corms provide the sole organ of perennation over the dry summers. Parent corms are annually replaced, globoid to ovate, white, fully enlarged to 0.5–1.5 cm diameter by the end of spring as above ground parts wither and dry. In winter a replacement daughter corm is produced alongside the parent corm, usually at the end of a shortly descending dropper stem. Protection is afforded by a pale brown scarios covering remaining from the previous-year's corms and leaf bases.

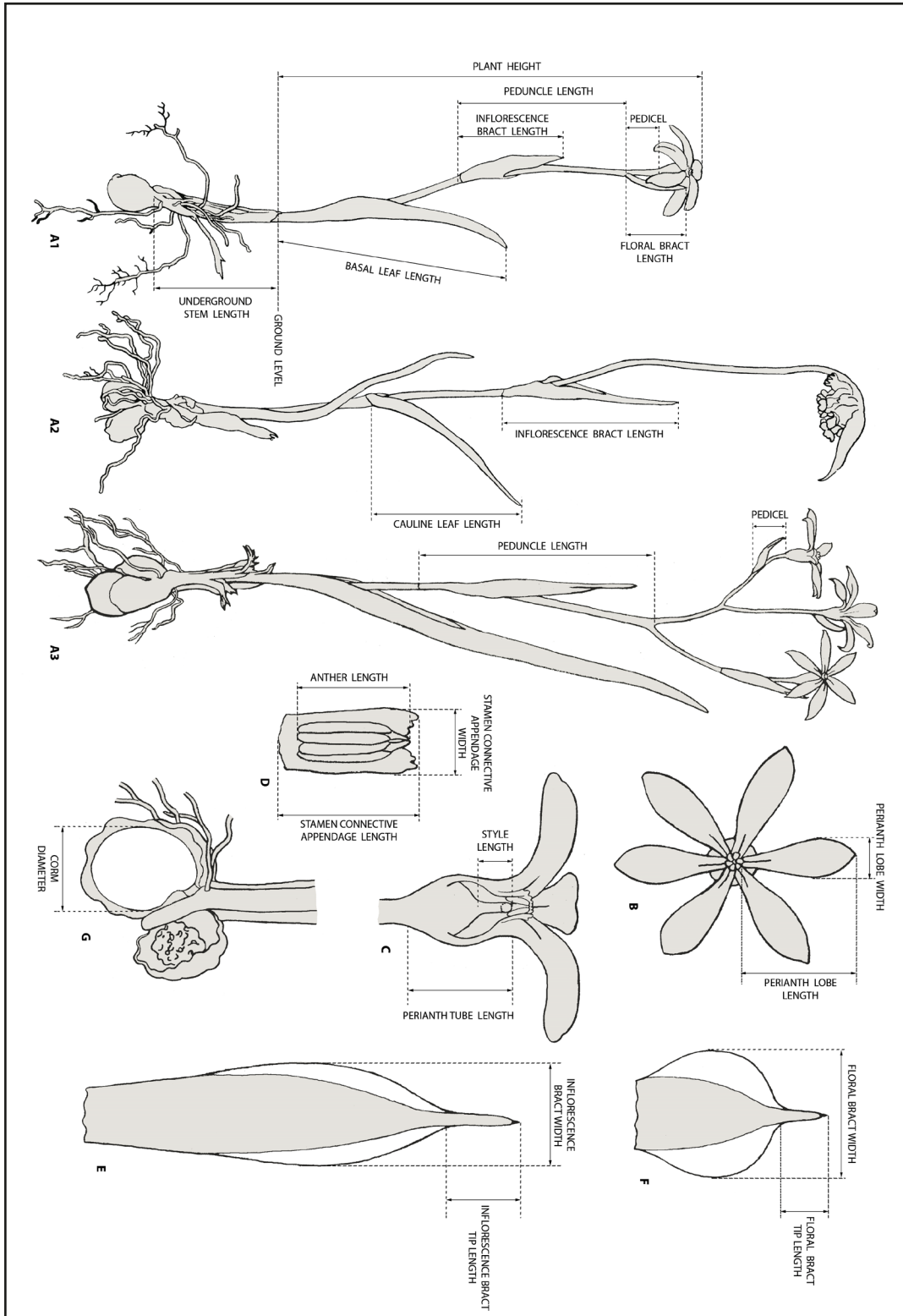


Figure 2. Caption opposite.

Flowering. Flowering has been claimed to be obligately fire-stimulated for all *Tribonanthes* species (Lamont & Downes 2011). However, several species found on granite outcrops flower in the absence of recent fire (e.g. *T. australis*, *T. brachypetala*, *T. monantha*, *T. purpurea*, *T. uniflora*, *T. variabilis*, *T. violacea*), as does the salt-lake endemic *T. minor* and species of ephemeral ponds such as *T. keigheryi*. Facultative flowering after fire is seen in species when they grow in other damplands such as *T. brachypetala* and *T. violacea* on paperbark (*Melaleuca* spp.) flats.

Aerial stem (Figure 4). The aerial stem is terete in cross section. It is glabrous from the basal leaf to the inflorescence bract, although sometimes there are scattered trichomes near the base of the inflorescence bract attachment, and then it is covered in woolly white trichomes above the inflorescence bract attachment to the base of the inflorescence, except *T. purpurea* which is glabrous throughout. *Tribonanthes brachypetala* and *T. variabilis* also possess a cauline leaf on the stem between the basal leaf and the inflorescence bract. Aerne-Hains and Simpson (2017) found in *T. australis* (? *T. variabilis*) that the aerial stem has a cortex of two to several cells thick, consisting of irregularly shaped cells. A sclerenchyma cylinder is present consisting of two to several cell layers, distinct from the adjacent cortical cells at the outer edge and grading into the parenchyma cells at the inner edge. Vascular bundles are inside the sclerenchyma cylinder, randomly arranged throughout, extending into the parenchyma but not found in the centre of it. Vascular bundles are often surrounded by sclerenchyma.

Basal leaves (Figure 4). These are 1.5–46 cm long (1.5–2.5 cm in *T. minor* and 2.5–5.5 cm in *T. purpurea*), basal (sub-basal to 7.5 cm above ground in *T. porphyrea*), narrowly linear to filiform (e.g. *T. keigheryi*), distinctly flat (e.g. *T. longipetala*), otherwise terete, with a long open basal sheath. The basal sheath has a narrow membranous margin, colourless or tinged pink to deep purple-red and no fringing trichomes. In Aerne-Hains & Simpson's (2017) study of the vegetative anatomy of Haemodoraceae, the epidermis of the leaf of *Tribonanthes australis* (? *T. variabilis*), *T. brachypetala* and *T. longipetala* (? *T. uniflora*) consisted of a single layer of cells. The epidermal cells are axially elongated, being longer than wide, with the cell body raised relative to the junction with the adjacent cells. Epidermal papillae are absent. Stomata are scattered across the leaf surface with each stomate having two paracytic subsidiary cells. The vascular bundles are arranged in a ring at the junction of the palisade and spongy mesophyll. Within the vascular bundles the xylem consists of two to 10 layers of vessels and phloem consists of two to eight layers of sieve members. *Tribonanthes* lack fibres enveloping the vascular bundles, which are usually present in the Haemodoraceae (Aerne-Hains & Simpson 2017). The cells of the bundle sheath are irregular and not surrounded by sclerenchyma. The palisade region contains scattered tannin cells. The leaves are fistulose with the spongy mesophyll containing aerenchymous cells, with the exception of *T. minor* and *T. purpurea*. The lack of fibres and presence of the aerenchyma cells in the leaves of *Tribonanthes* are consistent with features present in species that dwell in habitats that are at least periodically wet (Aerne-Hains & Simpson 2017).

Cauline leaves (Figure 4). *Tribonanthes brachypetala* and *T. variabilis* (not illustrated in Figure 2) often possess one or two cauline leaves between the basal leaf and inflorescence bract. It is shorter than the basal leaf, with a broad sheathing base and becoming terete above. The basal sheath has a narrow membranous margin, colourless or tinged pink to deep purple-red and no fringing trichomes. The apex is sometimes mucronate.

Figure 2 (opposite). Diagram of a *Tribonanthes* plant indicating quantitative characters measured (not to scale). A – whole plants including above and below ground parts; B – flower viewed from top; C – longitudinal section through flower; D – stamen showing anther and stamen connective appendage; E – inflorescence bract (splayed out) showing transparent margins; F – floral bract (splayed out) showing transparent margins; G – longitudinal section through underground corms showing this seasons corm, last seasons shrivelled corm and downward extension of stem forming next seasons corm. Illustration by E.J. Hickman.

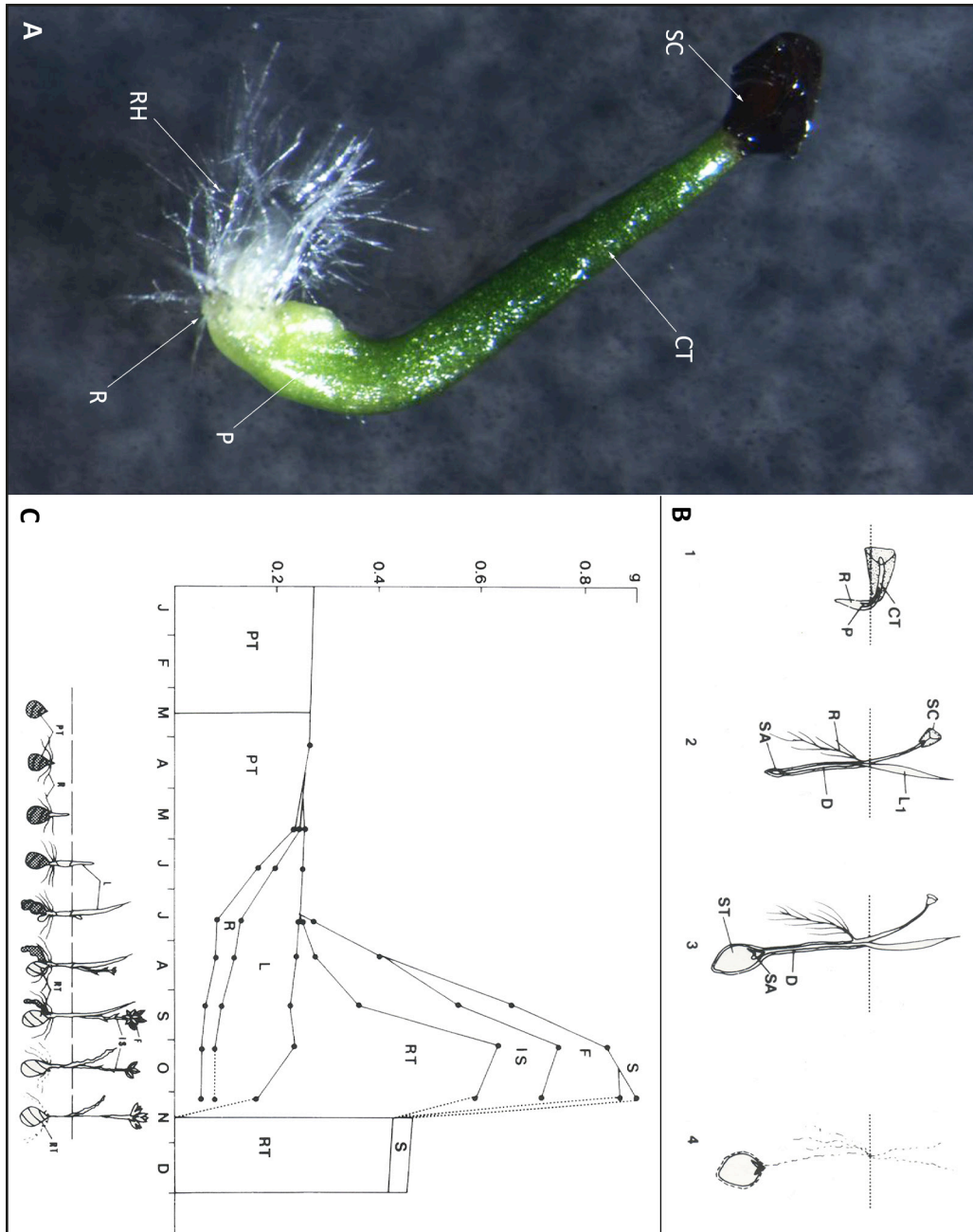


Figure 3. Seedling development and seasonal phenology of *Tribonanthes*. A – germinating seed of *T. keigheryi* (CT – cotyledon, P – plumule, SC – seed coat, R – radicle, RH – root hairs); B – seedling morphology of *T. variabilis*, showing mode of formation and burial of first-season’s storage organs. Stages in seedling development are arranged in numbered sequence, the last stage showing the likely condition of the seedling on entering dormancy at the end of the first season of growth (CT – cotyledon; P – plumule; R – radicle; L1 – seedling leaf; SA – stem apex; SC – seed coat; D – ‘dropper’ shoot; ST – stem tuber). Ground level marked by a dotted line. (From Pate & Dixon 1982: 22-23); C – phenology of growth, dry matter production and reproduction in the geophyte *T. variabilis*. Morphological changes accompanying growth are recorded and provide a key to the symbols for plant organs used in the cumulative plots of change in dry matter of plant organs. A single parent stem tuber (stippled and marked PT) is replaced by a single replacement tuber (RT) (R – root; L – leaf; IS – inflorescence stem; F – flowers; S – seed). Total rainfall for the year of harvest was 923 mm. Long-term rainfall average for harvest site was 873 mm. (From Pate & Dixon 1982: 168). Image by R.J. Smith, Royal Botanic Gardens, Kew (A).

Inflorescence bract (Figure 4). The inflorescence bract is solitary. It is shorter than the basal (and cauline) leaf (0.6–13.8 cm). The bract is usually well-separated from basal leaves to a third or more up the stem, with a broad sheathing base and becoming shortly terete above. The apex is sometimes mucronate. The basal sheath has a broad membranous margin, and is colourless or tinged pink, lilac, or deep purple-red. In *T. australis*, *T. keigheryi*, *T. porphyrea* and *T. uniflora* the bract has trichomes along the margin.

Peduncle. The peduncle is the structure between the base of the inflorescence bract and the base of the floral bract (or lowest floral bract), with the exception of *T. longipetala*, with its conspicuous branching, where the upper limit of the peduncle is the lowest branching point (Figure 2). *T. longipetala* is anomalous in its open inflorescence with wide branching, which usually lacks a bract at the lower branch points. The base of the peduncle is the node at the base of the inflorescence bract.

Pedicel (Figure 4). Pedicel from the insertion of the floral bract to the base of the ovary. Pedicels are absent (e.g. *T. minor*) or vary in length up to 30 mm (e.g. *T. longipetala*).

Floral bracts (Figure 4). Inflorescences are either a solitary flower or a compact or loosely arranged cyme. A floral bract subtends each flower. The floral bracts are elliptic to orbicular. They have a terete tip which is sometimes mucronate. There are three to five prominent veins, broad membranous margins that are pale green or tinged pink or lilac, and fringed with colourless trichomes, except *T. purpurea* which is glabrous.

Flowers and perianth (Figure 5). Flowers are actinomorphic, slightly zygomorphic in *T. minor*, tubular, and with six perianth lobes. The lobes vary from narrow linear to broadly obovate. The perianth lobes can be longer than, equal or shorter than the perianth tube. They can be erect, spreading or strongly reflexed. The perianth tube is covered in silky or woolly white trichomes, sometimes tinged purple on the outer surface but the inner surface is glabrous and ranges in colour from white, pale green to a deep yellowish green. The perianth lobes are covered in silky or woolly white trichomes, sometimes tinged purple on both outer and inner surfaces, sometimes the centre of the outer surface has less trichomes and can have a central broad stripe that is either green or purple in colour. The exception is *T. purpurea* which has pink, glabrous flowers.

Stamen connective appendages (Figure 6). A distinctive feature of *Tribonanthes* is the presence of stamen connective appendages (Simpson 1990). Detailed developmental studies and homology issues require further studies to determine the anatomical origins of these structures. Their function is completely unknown. The stamen connective appendage includes the filament and the appendage, which are not easily distinguishable. The appendages consist of either two small lateral points at the top of the filament (e.g. *T. purpurea*, *T. keigheryi*), or a spreading apex of either short dentate points or more petal-like structures, sometimes with longitudinal ridges on the back (abaxial) surface, or a cluster of fleshy finger-like structures (*T. minor*, *T. monantha*), or a broad fleshy structure with dentate top and longitudinal ridges on the back surface (*T. brachypetala*). The stamen connective appendages are either white to cream or bright yellow in colour under natural light, aging to deep orange. The stamen connective appendages can be shorter than, equal to or project above the anthers, collectively forming a distinct corona-like structure.

Anthers (Figure 6). The anthers are yellow, except in *T. minor* in which they are cream. In terms of location of the anther on the stamen connective appendage, they appear centrally placed, or less frequently occupy the apical half (i.e. *T. keigheryi*, *T. purpurea*, *T. violacea*), or the basal half (i.e.

T. minor, *T. monantha*). The locules are free below the attachment and fused above with a sterile apex, whose function is unknown. They dehisce introrsely through longitudinal slits.

Pollen. *Tribonanthes* has globose-spherical pollen grains usually with 5 flattened apertures (sometimes 6–7) and scattered exinous elements (Simpson 1983; Pierce & Simpson 2009).

Styles and stigmas (Figure 6). The style is usually sub-sessile or short, stout and green, or with purple longitudinal striations, except *T. purpurea* where it is slender-filiform and elongated. The stigma is terminal, simple or has a prominent tuft of silky white trichomes at the apex (i.e. *T. elongata*, *T. longipetala*, *T. variabilis*, less so in *T. porphyrea*), or three protuberances at the apex (i.e. *T. brachypetala*, less so in *T. porphyrea*).

Nectaries. Simpson (1993) described *T. variabilis* as having three supralocular septal nectaries primarily traversing the exposed portion of its half-inferior ovary. They open to the outside at the extreme distal end of their extent, near the base of the style. They are composed of a single layer of radially elongated nectar-secreting epithelial cells. Ovary position influences the type and extent of nectaries, so other species of *Tribonanthes* may have different nectaries depending on their ovary position (Simpson 1993).

Ovary (Figure 7). The ovary is superior (i.e. *T. minor* and *T. purpurea*), inferior (i.e. *T. elongata* and *T. longipetala*) or otherwise half-inferior, except *T. variabilis* which can be half-inferior to inferior. The ovary consists of three locules. All species have axile placentation. The number of ovules per locule illustrated in Figure 7 was counted from available botanical drawings herein. It varied between different species: *T. brachypetala* (6 ovules); *T. purpurea* (7); *T. longipetala* (9); *T. minor* (10–12); *T. keigheryi* (14); *T. uniflora* (15); *T. monantha* (25); *T. elongata* (26); *T. variabilis* (26); *T. australis* (48); *T. violacea* (55); and *T. porphyrea* (78). *Tribonanthes brachypetala* displays early abortion of some ovules resulting in only a few seeds per capsule.

Capsule (Figure 7). All species have 3-valved capsules. The ovary swells as the seeds enlarge. The perianth is persistent, with the perianth lobes remaining reflexed or becoming erect, except *T. variabilis* where the perianth lobes remain spreading, prior to dehiscence. The perianth lobes then become reflexed post-dehiscence, except in *T. purpurea* where they are spread slightly from the erect position. When mature the capsule splits loculicidally from the apex to a third or half way down the central ridge of each carpel.

Seeds (Figure 7). Seeds of all species except *T. minor* are 1.0–2.2 mm in length, irregularly ovoid or cuboid with angular folds and a few ridges. The seed shape is affected by compression between neighbouring seeds during development. The seeds are brown tending to purple-grey, glabrous, with a starchy endosperm and a minute embryo near the micropyle. Those of *T. minor* are noticeably diminutive, measuring 0.4–0.5 mm in maximum length. The seeds have no specialised means of dispersal and appear to be released as capsules are shaken by wind and rain. Presumably the seeds do not fall far from the parent plant.

Chromosomes. Simpson (1990) reported $N=7$ for an unknown *Tribonanthes* species. This chromosome count was attributed to “G.J. Keighery pers. comm.” However, Hopper and Stone (cited in Hopper *et al.* 2006) obtained $N=11$ for *T. variabilis* from Mt Benia and Toodyay Road. Moreover, G.J. Keighery (pers. comm. 2005) has no record of a count of $N=7$ for *Tribonanthes*. The report of $N=7$ for the genus was an error in Simpson (1990) (Simpson pers. comm. 2005). Subsequently, cytological collections by EJH of most species in the genus failed to yield squash preparations of pollen mother cells and root tips suitable for chromosome counts.



Figure 4. Caption on page 103.



Figure 5. Caption on page 103.

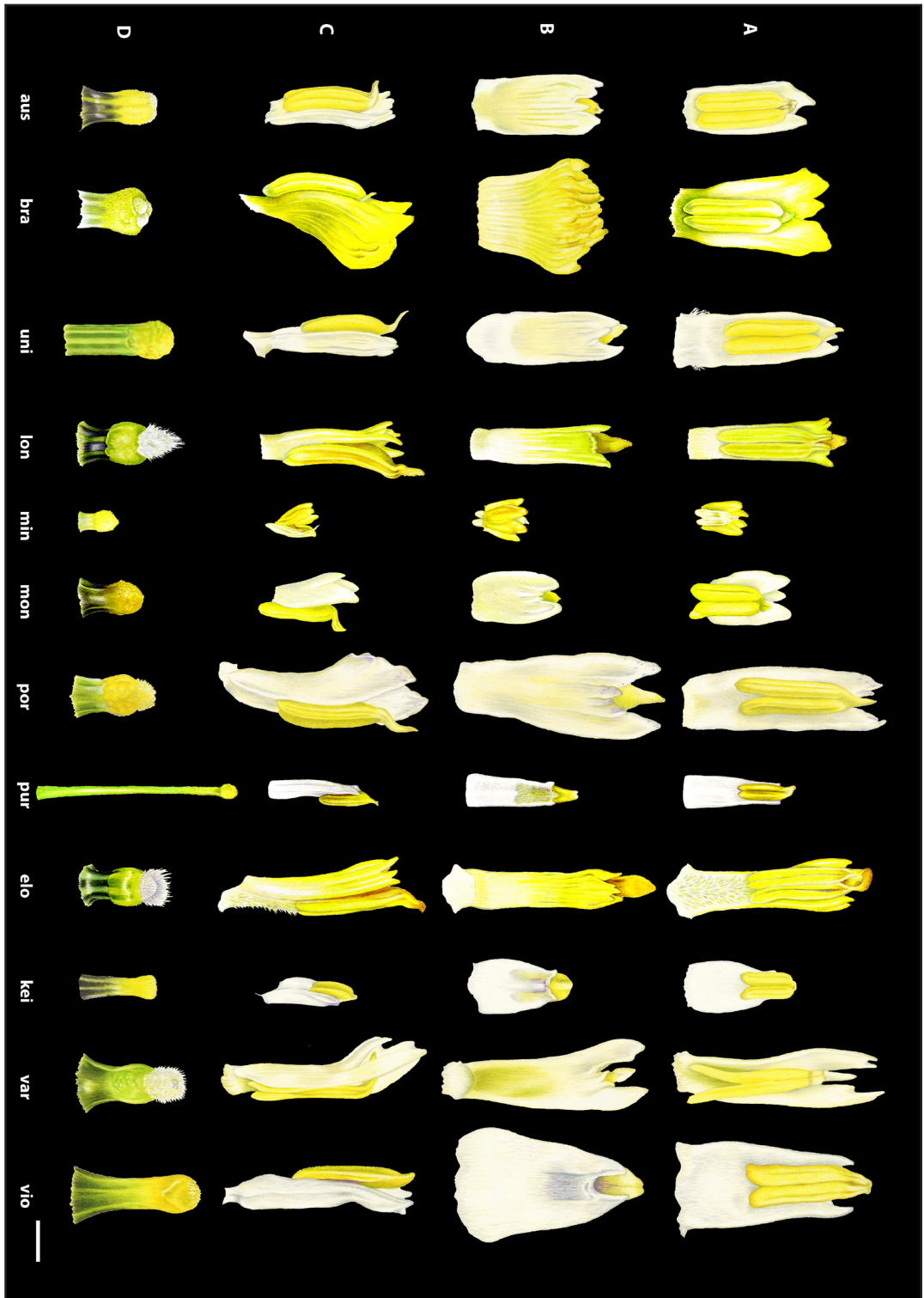


Figure 6. Caption on page 103.



Figure 7. Caption opposite.

Figure 4 (page 99). Whole plant specimens of the twelve *Tribonanthes* species to scale (dashed line indicates ground level). A – *T. brachypetala* (no voucher, from Millinup Rd, south side of Porongurup Range after a fire in 2010); B – *T. australis* (E.J. Hickman 2067); C – *T. violacea* (E.J. Hickman 2090); D – *T. purpurea* (E.J. Hickman 2083); E – *T. uniflora* (E.J. Hickman 2084); F – *T. minor* (E.J. Hickman 2079); G – *T. longipetala* (E.J. Hickman 2021); H – *T. monantha* (holotype E.J. Hickman 2048); I – *T. porphyrea* (holotype E.J. Hickman 2025); J – *T. elongata* (holotype E.J. Hickman 2073); K – *T. keigheryi* (holotype E.J. Hickman 2065); L – *T. variabilis* (E.J. Hickman 2053). Scale bar = 20 mm. Discoveries through illustrations for particular species include the variation in peduncle length (species C, D, I and K have little to no peduncle, while all other species have relatively long peduncles); the sub-basal leaf up to 7.5 mm above ground level (species I). Illustrations by E.J. Hickman.

Figure 5 (page 100). Flowers of *Tribonanthes* species viewed from top or face-on (A–L) and with half perianth removed to show ovary position, stamen, stamen connective appendages and style (M–X). A – *T. australis*; B – *T. monantha*; C – *T. purpurea*; D – *T. elongata*; E – *T. uniflora*; F – *T. minor*; G – *T. longipetala*; H – *T. brachypetala*; I – *T. variabilis*; J – *T. porphyrea*; K – *T. violacea*; L – *T. keigheryi*. M – *T. australis*; N – *T. monantha*; O – *T. purpurea*; P – *T. elongata*; Q – *T. uniflora*; R – *T. minor*; S – *T. longipetala*; T – *T. brachypetala*; U – *T. variabilis*; V – *T. porphyrea*; W – *T. violacea*; X – *T. keigheryi*. Scale bar = 2.5 mm. Discoveries through illustrations for individual species include: difference in ratio of length to width of perianth lobes (particularly A>I and G>J distinguishing these species pairs); position of ovary (inferior – P, S, half-inferior – M, N, Q, T, U, V, X, superior – O, R, half-inferior to inferior – W). Voucher specimens as cited in caption for Figure 4. Illustrations by E.J. Hickman.

Figure 6 (page 101). Stamen and styles of *Tribonanthes* species. A – stamen viewed from front; B – stamen viewed from back; C – stamen viewed from side; D – style and stigma; aus – *T. australis*; bra – *T. brachypetala*; elo – *T. elongata*; kei – *T. keigheryi*; lon – *T. longipetala*; min – *T. minor*; mon – *T. monantha*; por – *T. porphyrea*; pur – *T. purpurea*; uni – *T. uniflora*; var – *T. variabilis*; vio – *T. violacea*. Scale bar = 1 mm. Discoveries through illustration for particular species include: colour of stamen connective appendages (cream – aus, uni, mon, por, pur, kei, var, vio; yellow – bra, lon, min, elo); colour of anthers (yellow – aus, bra, uni, lon, mon, por, pur, elo, kei, var, vio; cream – min); position of attachment of anther on stamen connective appendage (central – aus, bra, uni, lon, por, elo, var; lower – min, mon; upper – pur, kei, vio); trichomes on inner surface of filament (elo); relative length of style (sub-sessile – aus, bra, lon, min, mon, por, elo, var; short – uni, kei, vio; long – pur); style colour (green – bra, uni, min, por, pur, var; purple striations – aus, lon, mon, elo, kei, vio); stigma colour (yellow – aus, bra, uni, min, mon, por, pur, kei, var, vio; green – lon, elo, var); stigma vestiture (none – aus, uni, min, mon, pur, kei, vio; tuft of silky white trichomes – lon, por, elo, var; three protuberances – bra, por). Voucher specimens as cited in caption for Figure 4. Illustrations by E.J. Hickman.

Figure 7 (opposite). Capsules and seeds of *Tribonanthes* species. A – immature capsule; B – T.S. capsule; C – L.S. capsule; D – dehisced capsule; E – seeds from side top and sectioned to show seed volume; aus – *T. australis*; bra – *T. brachypetala*; elo – *T. elongata*; kei – *T. keigheryi*; lon – *T. longipetala*; min – *T. minor*; mon – *T. monantha*; por – *T. porphyrea*; pur – *T. purpurea*; uni – *T. uniflora*; var – *T. variabilis*; vio – *T. violacea*. Scale bars = 5 mm (A, B, C, D); 1 mm (E). Discoveries through illustration for particular species include persistent perianth position before dehiscence (erect – aus, uni, mon, por, kei, vio, pur; splayed – lon, elo, var; reflexed – bra, mon); persistent perianth position after dehiscence (reflexed – aus, uni, lon, mon, por, elo, kei, var, vio, bra, min; upwardly splayed – pur); ovules per locule (<10 – bra, pur, lon; 10–25 – min, kei, uni, mon; 25–50 – elo, var, aus; >50 – vio, por); the relative size of seeds particularly the diminutive *T. minor* seeds. Voucher specimens as cited in caption for Figure 4. Illustrations by E.J. Hickman.

Molecular Phylogeny

Early analysis of the molecular phylogeny of the Haemodoraceae included a few species of *Tribonanthes* (Hopper *et al.* 1999, 2009). Some of the identifications in these studies need updating in light of this present revision. This update is being done, and a more comprehensive study of all twelve species at up to eight populations each is underway.

Current evidence unequivocally establishes the monophyly of *Tribonanthes* as a genus (Hopper *et al.* 2009). Morphological, ecological and current unpublished molecular studies indicate strong support for recognition of *T. minor* and *T. purpurea* as monotypic subgenera.

It seems clear that further species-level resolution of the phylogeny of *Tribonanthes* and a clearer understanding of the role of natural hybridization in the genus will require next generation sequence data.

Taxonomy

Tribonanthes Endl. in S. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 4: 27 (1839). *Type: Tribonanthes australis* Endl.

Herbs, perennial terrestrial geophytes, erect (usually) but stemless or nearly so in *T. purpurea*, to 41 cm tall. *Corms* annually replaced at the end of a short, vertically descending dropper emergent near the top of the parent corm, globose to ovate, white, to 0.5–1.5 cm diameter when fully enlarged, ensheathed with brown scarious papery multi-layered tunic. *Roots* annually replaced, emergent from the top of the corm, colourless, sinuous, lacking a rhizosheath, or sometimes with a loose sand-binding rhizosheath (*T. longipetala*), c. 1 mm diameter. Leaves 1(–3), usually 1 basal, occasionally additional leaves on aerial stem (*T. brachypetala*, *T. variabilis*); sheath cylindrical, closely (or loosely) surrounding the stem, dilated and funnel-like in upper part, with margins fused (or free); lamina terete, sometimes slightly grooved or flat, narrowly linear. *Inflorescence* terminal, a single flower, a compact or loose cyme, or bifurcate pair of helicoid cymes; axes lanate, bracts usually glabrous with hairy margins. *Flowers* actinomorphic, slightly zygomorphic in *T. minor*, white, sometimes tinged purple, rarely purplish pink (in *T. purpurea*). *Perianth* shortly tubular, white-lanate, the 6 lobes imbricate, divergent or reflexed at anthesis. *Stamens* 6, inserted at base of the perianth lobes; filament connective extended upwards as an apically lobed, fleshy, yellow or cream flange often irregularly serrate at top; *anthers* dorsifixed with sterile apex, dehiscence longitudinal. *Ovary* inferior, half-inferior or superior, globose, with few to numerous ovules (c. 6–80 per locule), anatropous or heterotropous, the roof green. *Style* broadly conical or slender-filiform; stigma capitate, yellow or green, obscurely 3-lobed with elongate apex sometimes tufted with short trichomes or topped with 3 protuberances. *Capsules* enlarged, ellipsoidal, loculicidally dehiscent. *Seeds* globose or cuboidal angular, often irregular and variable in the one capsule, purplish grey-brown.

Etymology. From the Greek *tribon* (threadbare cloak) and *anthos* (flower), which could refer to the cobwebby-woolly indumentum of the flowers of most species (Macfarlane 1987) or to the stamen connective appendages ‘which rise above the anthers’ (Sharr 1996: 69).

Notes. *Tribonanthes* is a taxonomically isolated genus within Haemodoraceae subfamily Conostyloideae (Lindl.) T. Macfarlane & Hopper, placed in its own monotypic tribe Tribonantheae (Macfarlane & Hopper 1987; Simpson 1990; Hopper *et al.* 1999, 2009; Smith *et al.* 2011). The 12 species share a common ecology as inhabitants of seasonally water-logged or shallowly inundated clay-based wetlands or seeps and moss mats on granite outcrops. These are often old, climatically-buffered infertile landscapes (Hopper 2009; Hopper *et al.* 2016), refugial habitats from today’s strongly seasonal Mediterranean climate, implying that ecological niche conservatism is a hallmark of *Tribonanthes*.

The genus is most diverse in higher rainfall provinces of the SWAFR (Gioia & Hopper 2017), with a few species penetrating further inland in locally mesic habitats afforded by granite outcrops or seasonal damplands. Occupying such habitats are the two smallest species, the granite pink (*T. purpurea*) and the diminutive salt-lake tiurndin (*T. minor*). These are the only taxa of conservation concern. Their population structures are quite insular, and their habitats at some risk to disturbance processes affecting granite outcrops and freshwater rises on the margins of salt lakes respectively. In particular, threats include grazing by native mammals and feral rabbits and pigs, mechanical disturbance of granite moss mats by recreational or mining vehicles, the risk of salinization due to land clearing and climate change, and invasion of habitats by weeds.

Based on our field, morphological and molecular studies it is reasonable to recognise three subgenera in *Tribonanthes*, two of which are monotypic; they are keyed out below.

Key to subgenera of *Tribonanthes*

- 1. Perianth white with spreading or reflexed lobes
 - 2. Aerial stem up to 3 cm tall.....subg. **Salina**
 - 2: Aerial stem longer than 5 cm tall.....subg. **Tribonanthes**
- 1: Perianth purple-pink with erect lobes.....subg. **Boya**

Key to species of *Tribonanthes*

Note. Species are listed by relatedness, based on our morphological studies and initial results from continuing molecular studies, and numbered consecutively below for the entire genus.

- 1. Inflorescence multi-flowered
 - 2. Stamen connective appendages white to cream
 - 3. Stigma glabrous or few scattered trichomes..... **1. T. australis**
 - 3: Stigma with tuft of trichomes..... **8. T. variabilis**
 - 2: Stamen connective appendages yellow
 - 4. Perianth lobes spreading..... **3. T. longipetala**
 - 4: Perianth lobes strongly reflexed **10. T. brachypetala**
- 1: Inflorescence 1(–2) flowered
 - 5. Stamen connective appendages yellow
 - 6. Perianth lobes spreading..... **6. T. elongata**
 - 6: Perianth lobes strongly reflexed **11. T. minor**
 - 5: Stamen connective appendages white to cream
 - 7. Stamen connective appendages residual
 - 8. Perianth lobes erect, glabrous **12. T. purpurea**
 - 8: Perianth lobes spreading, hairy
 - 9. Inflorescence bract sheath margin hairy, fine slender plant, swamp dweller **7. T. keigheryi**
 - 9: Inflorescence bract sheath margin glabrous, robust plant, granite dweller **9. T. violacea**
 - 7: Stamen connective appendages prominent
 - 10. Stigma with tuft of trichomes..... **5. T. porphyrea**
 - 10: Stigma glabrous or few scattered trichomes
 - 11. Inflorescence bract sheath margin glabrous **4. T. monantha**
 - 11: Inflorescence bract sheath margin hairy **2. T. uniflora**

Tribonanthes Endl. subg. **Tribonanthes**

Aerial stem more than 5 cm tall. *Flowers* erect, solitary or few per inflorescence. *Perianth* with white spreading lobes, or with green reflexed lobes. *Style* 0.4–3.2 mm long.

Notes. A subgenus of ten species regarded as the typical tiurndins with white lanate erect (rarely nodding, i.e. *T. brachypetala*) star-like flowers. Found on granite outcrops or seasonal damplands or in shallow pools.

1. Tribonanthes australis Endl. in S. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 4: 27 (1839).

Type: King George Sound, Western Australia, *C. Hügel s.n.* (*holo:* W, *n.v.* – destroyed in fire during World War II [E. Vitek *pers. comm.* 6 May 2016]). *Neotype* – illustration in S. Endlicher, *Icon. Gen. Pl.* t. 109 (1841), here chosen (Figure 1).

Illustrations. S. Endlicher, *Icon. Gen. Pl.* t. 109 (1837–41) – Fig. 1.; A. Schnizlein *Iconogr. i. t.* 62 Fig. 4 (1843); W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); J. Scott & P. Negus *Wildfl. Aust. S.W.* p. 44 Fig. 5 (2002).

Herb annually renewed from a white ovoid corm, 17–41 cm tall, consisting of a single stem and single basal leaf. *Corms* 10–12.5 mm diameter, covered by numerous old brown, papery sheaths, 3.2–8.9 cm below soil surface. *Roots* white, simple with no visible root trichomes and no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 2.6–29.4 cm, glabrous. *Basal leaf* 8–23 cm long, erect, stem-clasping to terete, red-purple base grading to deep green apically, with dark mucronate tip, glabrous. *Inflorescence bract* 2.7–10.8 cm long, erect, funnel-like sheath with broad dilated mouth, 6–10 mm circumference at widest point, green with noticeable longitudinal veins and thin scarious margins fringed with white trichomes; lamina 10–61 mm long, terete, green, with darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to floral bract) 7.5–26 cm long, covered in white woolly trichomes, sparser towards inflorescence bract. *Inflorescence* a compact cyme of 2–5 sessile or shortly pedicellate flowers, each subtended by a single floral bract. *Floral bract* ovate, 5–11 mm long, 2–7 mm wide, greenish-purple with prominent longitudinal veins, hairy on margins and at base outside, glabrous inside, with a short terete mucronate apex, 1–2 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 5–9.1 mm long, 2–4.8 mm wide, spreading, obovate to elliptic, inner surface white hairy, outer surface purple with white trichomes sparser along centre of lobe, tips dark mucronate. *Perianth tube* 3–7 mm long, outer surface covered in long silky white trichomes, inner surface pale green, glabrous. *Stamen connective appendages* 2–4 mm long, 1.3–1.5 mm wide, creamy white, topped with 4 or 5 finger-like projections with rounded tips, equal to slightly exceeding anther tips. *Anthers* 1.5–3.3 mm long, yellow, with cream sterile apex that projects towards centre of flower, attached centrally on stamen connective appendages. *Ovary* green, half-inferior, locules 3, with many (48) ovules per locule. *Style* 0.6–2 mm long, with green and purple longitudinal striations. *Stigma* yellow, with few scattered trichomes on upper surface. *Capsule* with perianth persistent, erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 1, 8, 9)

Diagnostic features. Tall plant, terete leaf, long peduncles, multi-flowered inflorescence, white hairy flowers with faint tinge of purple, large creamy white stamen connective appendages, short to subsessile style with simple stigma bearing few scattered trichomes on upper surface, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: 7.2 km W of Denmark along South Coast Hwy, 18 Sep. 1991, *A.R. Annels* 1668 (PERTH); Kangaroo Rd, 4.1 km E of Collis Rd, Hazelvale, 14 Sep. 1994 *A.R. Annels* & *R.W. Hearn* 4416A (PERTH); banks of the Gordon River, N of Frankland, 13 Sep. 1973, *A.M. Ashby* 4899 (PERTH); Holland Rocks, 4.4 km from Newdegate–Pingrup Rd along Holland Tank Rd, 17 Sep. 2014, *A.M. Coates* 6735 (PERTH); road to water monitor, Waychinicup, E of Albany, 30 Oct. 1992, *E.J. Croxford* 6659 (PERTH); Table Hill Forest Block, Bevan Rd Denbarker, 8 Oct. 2007, *C.P. Dornan* 387 (PERTH); Nollajup Nature Reserve, 8 km SW Boyup Brook, 20 Sep. 2014, *E.J. Hickman* 2057 (PERTH); Mettabinup Nature Reserve, 3.3 km W on Flora and Fauna Rd from Tone Rd, then 500 m into reserve to SW boundary of reserve, 20 Sep. 2014, *E.J. Hickman* 2060 (PERTH); Wamballup Lake Nature Reserve, 500 m W on Wamballup Rd from Boyup Rd, S side of road in broad drainage line, 30 Sep. 2014, *E.J. Hickman* 2066 (PERTH); Mt Melville, 350 m SE from top carpark along Mt Melville Circuit Trail, both sides of trail, 31 Oct. 2014, *E.J. Hickman* 2067 (PERTH); 20 km S of Bridgetown towards Manjimup, 8 Oct. 1982, *G.J. Keighery* 5346 (PERTH); Porongurup Range, SW margin, below Halls Rock, 3 Nov. 1986, *G.J. Keighery* 8481 (PERTH); Moingup Spring, Chester Pass, Stirling Range, 20 Sep. 1987, *G.J. Keighery* 11382 (PERTH); Symmonds Block, Tuart Forest, W of Ludlow, 15 Sep. 1994, *G.J. Keighery* 13595 (PERTH); Cowerup Nature Reserve, 23 Oct. 1997, *G.J. Keighery* & *N. Gibson* 2749 (PERTH); 3 km E of Windy Harbour, 13 Nov. 1986, *M. Prest s.n.* (PERTH); Scott National Park camping reserve west, 17 Sep. 1990, *C.J. Robinson* 123 (PERTH).

Proposed vernacular name. Southern Tiurndin.

Phenology. Flowers from August to December.

Distribution and habitat. The species ranges from Augusta across the south-west corner of Western Australia to east of Albany, with an out-lying population recently recorded near Hollands Rock. It is mainly concentrated in the Jarrah and Muir Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), but there are collections from the Fitzgerald–Stirling and Maalak Districts of the Southeast Coastal Province. *Tribonanthes australis* grows on brown loams around granite outcrops associated with herbfields, shrublands and open woodlands, and on grey sandy clay in winter wet flats associated with shrublands and heathlands adjacent to open woodlands. Associated species include *Corymbia calophylla*, *Eucalyptus rudis*, *Eucalyptus wandoo*, *Melaleuca preissiana*, *Melaleuca viminea*, *Hakea prostrata*, *Taxandria marginata*, *Verticordia plumosa*, *Borya nitida*, *Drosera menziesii*, and *Stypandra glauca* (Figure 9).

Conservation status. Widespread with no special conservation needs.

Etymology. Named from the Latin for southern, alluding to its discovery at King George Sound near the southern-most part of the Swan River Colony.

Notes. Macfarlane (1987) synonymised *T. variabilis* under *T. australis*. However, while the stigma of *T. australis* can sometimes have scattered trichomes on the top, the prominent appendage covered in silky white trichomes, present on the stigma of *T. variabilis*, is absent. Also the perianth of *T. australis* is more noticeably tinged purple than the perianth of *T. variabilis*, and the perianth lobes of *T. australis* are generally narrower than *T. variabilis*, relative to their length. *Tribonanthes australis* is usually more south and east in its distribution (Figure 9C) while *T. variabilis* is found on the west coast (Figure 23C). Young plants of *T. australis* may appear to have a single-flowered inflorescence, and hence are confused with their smaller relatives, *T. monantha* and *T. uniflora*. *Tribonanthes australis* is identified as a herbaceous species in the floristic summary of the *Melaleuca cuticularis*/*M. preissiana* Open



Figure 8. *Tribonanthes australis*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting forwards; G – style sub-sessile with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, H, I, J, K, P, R); 1 mm (F, G, M, N); 4 mm (O, Q); 0.5 mm (L, S); 0.65 mm (T). Drawn from fresh material of *E.J. Hickman* 2067 (PERTH 08989354). Illustrations by E.J. Hickman.

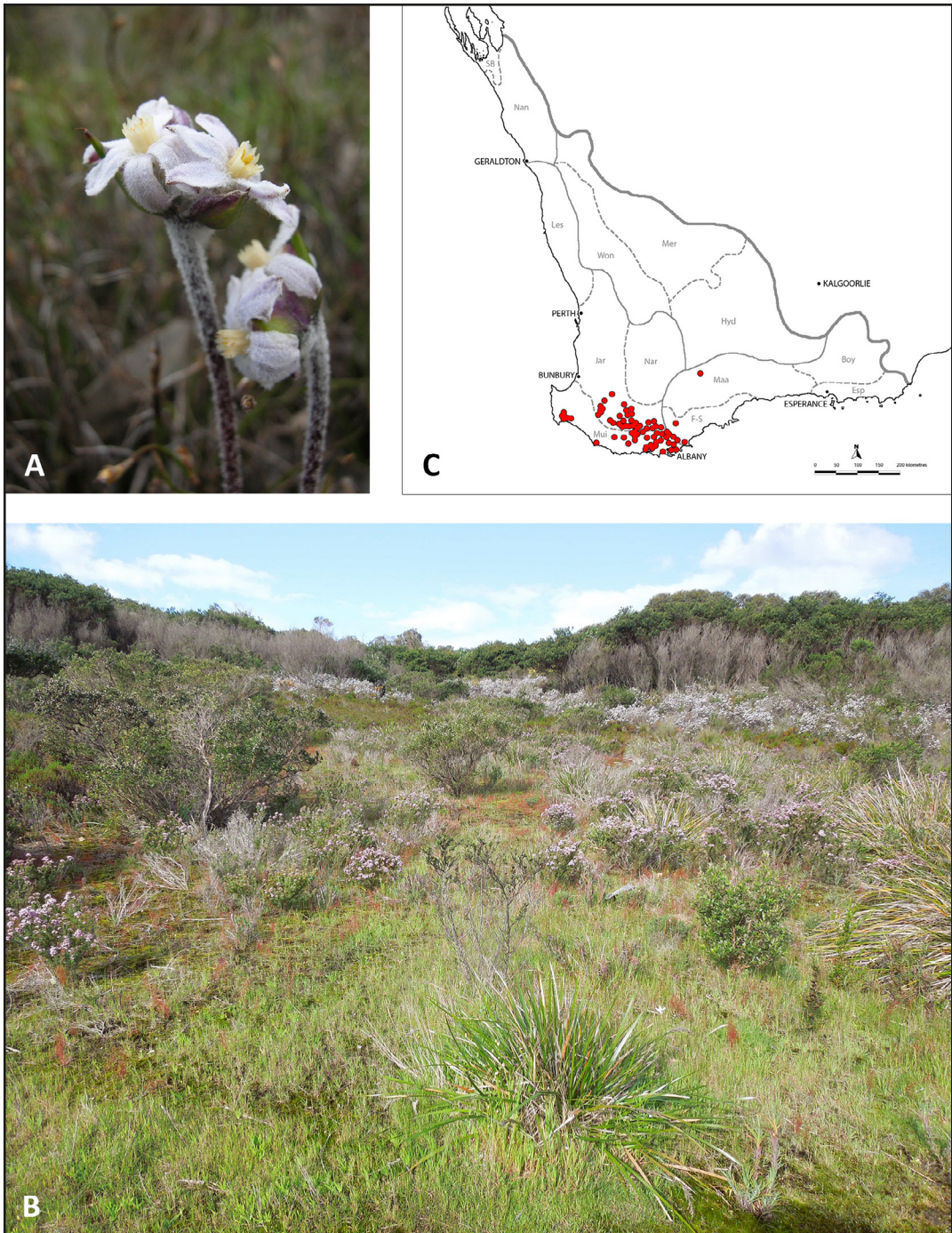


Figure 9. *Tribonanthes australis*. A – plants showing multi-flowered inflorescences (E.J. Hickman 2067); B – habitat (E.J. Hickman 2067), shrubland of *Taxandria marginata* and *Verticordia plumosa* associated with herbfield of *Stypantra glauca* and *Drosera menziesii* over granite on south-west slopes of Mt Melville, Albany, Western Australia; C – distribution in south-western Australia with *SWAFR* provinces and districts shown in grey (Kalbarri Province: SB – Shark Bay District, Nan – Nanda District; Bibbulmun Province: Les – Lesueur District, Jar – Jarrah District, Nar – Narrogin District, Mui – Muir District; Southeast Coastal Province: Maa – Maalak District, F-S – Fitzgerald-Stirling District, Boy – Boylya District, Esp – Esperance District; Transitional Rainfall Province: Won – Wongan District, Mer – Merredin District, Hyd – Hyden District (Gioia & Hopper 2017)). Photos by E.J. Hickman.

Woodland vegetation association, of the Albany Regional Vegetation Survey (Sandiford & Barrett 2010).

2. *Tribonanthes uniflora* Lindl., *Sketch Veg. Swan R.* xliv (1840).

Type: Swan River, Western Australia, *J. Mangles s.n.* (*lectotype:* CGE 06825! *vide* T.D. Macfarlane, *Fl. Australia* 45: 465 (1987)).

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); J.R. Wheeler in J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* Vol. 1: 314 (2002).

Herb annually renewed from a white ovoid corm, small to medium plant, 6.5–21.4 cm tall above ground, consisting of a single stem and single leaf. *Corms* 4–8 mm diameter, covered by numerous old brown, papery sheaths, 1.2–5.3 cm below soil surface. *Roots* white, no root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 1.5–15 cm, glabrous. *Basal leaf* 4–16.5 cm long, erect, stem-clasping to terete, red-purple base grading to green apically, with mucronate tip, glabrous. *Inflorescence bract* 1.4–6.4 cm long, erect, funnel-like sheath with broad dilated mouth, 4–8 mm circumference at widest point, red-purple, broad membranous margin tinged red and fringed with white trichomes, lamina 5–35 mm long, terete, green, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 0.4–7.7 cm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by one or two floral bracts. *Floral bract* obovate, 7–13 mm long, 3–8 mm wide, green with purple margin fringed with white trichomes and scattered trichomes on the base, with a short terete mucronate apex, 1–5 mm long, ending in a darker tip, exceeding perianth lobes. *Perianth lobes* 5–9.4 mm long, 1.5–3.2 mm wide, spreading, obovate, with white hairy inner and outer lobe surfaces, dark mucronate tips. *Perianth tube* 2.8–7.4 mm long, outer surface covered in long white woolly trichomes forming a distinctly fluffy skirt, inner surface white, glabrous. *Stamen connective appendages* 0.5–4 mm long, 1.2 mm wide, creamy white topped with 3 finger-like projections with rounded tips, equal to slightly exceeding anther tips. *Anthers* 1.5–3.4 mm long, yellow, with cream sterile apex that projects towards centre of flower, attached centrally on stamen connective appendages. *Ovary* green, half-inferior, locules 3 with several (15) ovules per locule. *Style* 0.7–2.5 mm long, green. *Stigma* simple, capitate, yellow, glandular, glabrous. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, spreading to reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 10, 11)

Diagnostic features. Small to medium plant, terete leaf, long woolly peduncles, solitary flowered inflorescence, woolly white flowers, obvious cream stamen connective appendages, medium style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Guildford, Sep. 1901, *C. Andrews s.n.* (PERTH); Coomalbidup, 4 Aug. 1965, *J. Bowens s.n.* (PERTH); Wandoo Conservation Park, Goonapping Swamp, 17 Sep. 2014, *K.L. Brown & G. Paczkowska* KLB 1153 (PERTH); N side of Lake Powell, W of Albany, 25 Sep. 1983, *D. Davidson s.n.* (PERTH); Cowalellup Rd, 1.2 km W of intersection with Boxwood Hill–Ongerup Rd, S side of road, 29 Oct. 2013, *E.J. Hickman* 2010 (PERTH); McNeil Rd, 2.6 km E of Kellerberrin–Yoting Rd, 100 m S of road side, 12 Sep. 2014, *E.J. Hickman* 2049 (PERTH); Moses Rock, 150 m S of T-junction at end of Moses Rock Rd, 50 m W to granite rock, 20 Sep. 2014, *E.J. Hickman* 2055 (PERTH); Mettabinup Nature Reserve, 3.3 km W along Flora and Fauna Rd from Tone Rd, then 500 m W into reserve to SW boundary, 20 Sep. 2014, *E.J. Hickman* 2061 (PERTH); Jingalup Nature Reserve, 1.1 km W of Kojonup–Frankland Rd on Settlers Rd, S side

of road in claypan, 20 Sep. 2014, *E.J. Hickman* 2062 (PERTH); Break Rd, 2.6 km W of turn-off to Mt Lindesay, N side of road, 3 Nov. 2014, *E.J. Hickman* 2071 (PERTH); Moses Rock, 150 m S of T-junction at end of Moses Rock Rd, 50 m W to granite rock, 16 Aug. 2016, *E.J. Hickman* 2084 (PERTH); 8 km S of Eneabba, 27 Sep. 1977, *R. Hnatiuk* 771396 (PERTH); Kemerton, 2 Sep. 2003, *G.J. & B.J. Keighery* 261 (PERTH); Pinjarra Nature Reserve, 30 Aug. 2007, *G.J. Keighery* 17134 (PERTH); 17.2 km W of Northampton on Port Gregory Rd, 25 July 2009, *G.J. & B.J. Keighery* 1569 (PERTH); Warrenup Nature Reserve, W of Kendenup, 19 Sep. 2009, *G.J. Keighery* 17561 (PERTH); Plain Rd, NW of Walpole, 21 Sep. 1983, *R. Ornduff* 9329 (PERTH); Mt Chudalup, 5 Sep. 1985, *J.R. Wheeler* 2389 (PERTH).

Proposed vernacular name. Woolly Tiurndin.

Phenology. Flowers from August to October.

Distribution and habitat. *Tribonanthes uniflora* is known from scattered populations both coastal and inland, from north of Geraldton to west of Esperance. Most collections are from the Jarrah, Muir and Lesueur Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), but there are collections from the Nanda District of the Kalbarri Province, Wongan District of the Transitional Rainfall Province and Maalak District of the Southeast Coastal Province. It grows on seasonally wet brown to grey sandy clays in moss swards and shallow soil pockets of granite sheets and outcrops or on winter wet flats associated with *Melaleuca* shrublands, open woodlands and forest fringes around granite. Associated species include *Eucalyptus occidentalis*, *E. rudis*, *Melaleuca preissiana*, *M. hamulosa*, *M. lateritia*, *M. uncinata*, *M. viminea*, *Hakea prostrata*, *H. varia*, *Verticordia plumosa*, *Dodonaea ceratocarpa*, *Xanthorrhoea preissii* and a variety of herbs and sedges (Figure 11).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin *unus* (one) and *florus* (flowered), referring to the single-flowered inflorescence of this species.

Notes. *Tribonanthes uniflora* collections have previously been identified as *T. australis*, *T. longipetala* or *T. violacea*. *Tribonanthes uniflora* differs from *T. australis* in having a smaller habit and a smaller, single-flowered inflorescence. It differs from *T. longipetala* in having terete leaves and shorter perianth lobes and obvious cream stamen connective appendages, rather than bright yellow stamen connective appendages. It differs from *T. violacea* in having an obvious peduncle, which is covered in woolly trichomes from the inflorescence bract to the first floral bract. This species is similar to *T. monantha* in its small stature and single-flowered habit but differs in having an inflorescence bract with a narrower transparent margin fringed with white simple trichomes. Also the flowers of *T. monantha* tend to turn purple at senescence while *T. uniflora* flowers remain white.

3. *Tribonanthes longipetala* Lindl., *Sketch Veg. Swan R.* xliv (1840).

Type: Swan River [Colony], Western Australia, 1839, *J. Drummond s.n.* (*lecto* here chosen: CGE 06824! left specimen; *isolecto*: K 000846201 image!); Swan River, Western Australia, *J. Mangles s.n.* (*syn*: CGE 06824! right specimen).

Tribonanthes lindleyana Endl. in Lehm., *Pl. Preiss.* 2: 27 (1846), *nom. illeg.*, *nom. superfl.* *Type:* Swan River [Colony], Western Australia, 1839, *J.A.L. Preiss* 1561 (*holo*: LD 1811505 image!; *iso*: MEL 104294 image!, P 01698194 image!, S 06-11224 *n.v.*).



Figure 10. *Tribonanthes uniflora*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing stamen connective appendages small, just shorter than anthers and yellow anthers with apex apiculate and projecting forwards; G – style slightly elongated with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root (scale bar = 0.5 mm); T – detail of perianth trichomes (scale bar = 0.65 mm). Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, O, P, Q, R); 1 mm (F, G, M, N); 2 mm (H, I, J, K); 0.5 mm (L, S); 0.65 mm (T). Drawn from fresh material from E.J. Hickman 2084 (PERTH 08988579). Illustrations by E.J. Hickman.

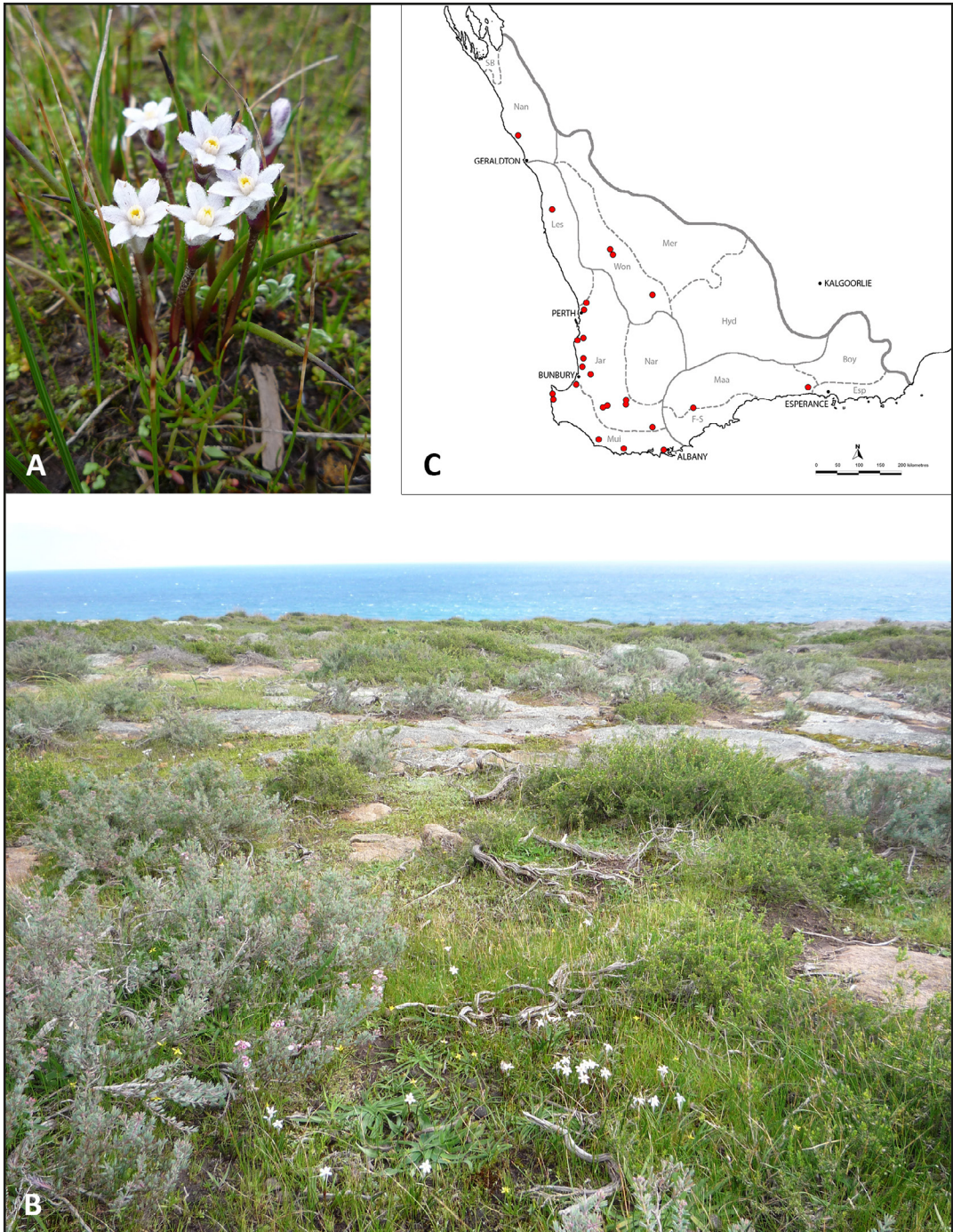


Figure 11. *Tribonanthes uniflora*. A – group of plants each with a solitary-flowered inflorescence, (E.J. Hickman 2084); B – habitat (E.J. Hickman 2084), granite pavement with wind pruned shrubs *Dodonaea ceratocarpa*, *Verticordia plumosa* var. *plumosa* and *Leucopogon parviflorus* over herbs, sedges and grasses at Moses Rock, south of Yallinup, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); T.D. Macfarlane in N.G. Marchant, J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane, *Fl. Perth Region* p. 859, Figure 310 (1987); T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52A–E (1987); J.R. Wheeler in J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* Vol. 1: 313 (2002).

Herb annually renewed from a white ovoid corm, 7.3–40 cm tall, consisting of a single branched aerial stem and single leaf. *Roots* white, with visible white root trichomes, that sometimes have an associated loose sand-binding rhizosheath. *Corms* 12.5–15 mm diameter, covered by numerous old brown, papery sheaths, 2–10 cm below soil surface. *Aerial stem* (from basal leaf to inflorescence bract) 2–13.3 cm, lower 1/2 glabrous, the remainder with scattered trichomes. *Basal leaf* 4.5–23 cm long, erect, sheath stem-clasping, lamina flattened, green, with dark mucronate tip, glabrous. *Inflorescence bract* 2.5–13 cm long, erect, stem-clasping below, 6–10 mm circumference at widest point, green with noticeable longitudinal veins and thin scarious margins; lamina 2–100 mm long, flattened, green with darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to lowest branching point) 3.3–28 cm long, covered in white woolly trichomes, sparser on lower 1/2. *Inflorescence* a loose cyme of 2–5 pedicellate flowers, each subtended by a single floral bract. *Pedicels* 30–60 mm long, covered in white woolly trichomes. *Floral bract* 11–22 mm long, 2–5 mm wide, lanceolate, green with prominent longitudinal veins, outside surface hairy at base, inside surface glabrous, margins membranous, hairy, apex shortly terete, 0.5–5 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 10–16 mm long, 2–4 mm wide, spreading to recurved, linear to narrowly obovate, inner and outer surfaces white woolly hairy, with purple tinge along midline of outer surface, apex with a dark mucronate tip. *Perianth tube* 4–7 mm long, outer surface covered in silky white trichomes, with longer silky trichomes at base forming a distinct skirt, inner surface pale green, glabrous. *Stamen connective appendages* small, 2.0–3.0 mm long, 1.1–1.2 mm wide, yellow, topped with 5–7 short rounded tips, their apices below anther tips. *Anthers* 3–4 mm long, yellow, with deep yellow sterile apex that projects upwards, attached centrally on stamen connective appendage. *Ovary* green, inferior, locules 3 with few (9) ovules per locule. *Style* short to sub-sessile, 0.7–2 mm long, green and purple longitudinal striations. *Stigma* capitate, green, with prominent tuft of white silky trichomes on top. *Capsule* greyish brown; perianth persistent; lobes spreading before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 12, 13)

Diagnostic features. Tall plant, flattened leaves, long peduncles, multi-flowered inflorescence with long pedicels, woolly white flowers with long narrow perianth lobes, small yellow stamen connective appendages, short to sub-sessile style, stigma with prominent tuft of silky white trichomes on top, inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: 4.8 km NW of Mount Yetar, 5 Nov. 1996, M.G. Allen 136 (PERTH); Ellis Brook Valley Reserve, 25 Aug. 1999, H. Bowler 411 (PERTH); Waroona, 29 Oct. 1997, R.J. Cranfield 11428 (PERTH); Lower Chittering, 26 July 1959, A.S. George 35 (PERTH); Baker's Hill Research Station, 26 Sep. 1962, D.W. Goodall 756 (PERTH); Talbot Rd Nature Reserve, 350 m W along central track from Talbot Rd, S side of track, 27 Aug. 2014, E.J. Hickman 2020 (PERTH); Gooseberry Hill, 170 m E of Watsonia Rd, and 210 m N of Gooseberry Hill Rd, 27 Aug. 2014, E.J. Hickman 2021 (PERTH); Wannamal Townsite, 7 Aug. 1997, R. Hindmarsh 19 (PERTH); Bodhinyana Monastery, Serpentine, 24 Aug. 2002, B. Nyanatusita 123 (PERTH); Qualen Rd, SW of York, 18 Sep. 1984, S. Patrick 148 (PERTH); 9 km SE of Bolton Pools, 13 Aug. 1997, G. Paull 1705 (PERTH).

Proposed vernacular name. Branching Tiurndin.

Phenology. Flowers from July to November.

Distribution and habitat. *Tribonanthes longipetala* has been collected from populations along the Darling Scarp, from Wannamal north of Perth to Waroona and east to Baker's Hill. Most collections are along the border between the Lesueur and Jarrah Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017). It grows on seasonally wet brown clay loam or sandy clays associated with granite or laterite on slopes or flats that are winter wet and associated with open woodlands, shrublands and herbfields. Associated species include *Corymbia calophylla*, *Eucalyptus wandoo*, *Acacia pulchella*, *Hakea lissocarpha*, *Xanthorrhoea preissii* and a variety of herbs and sedges (Figure 13).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin *longus* (long) and *petalum* (petal), referring to the long narrow perianth lobes of this species.

Notes. Based on determinations on herbarium specimens, Macfarlane (1987) did not distinguish our *T. elongata* from *T. longipetala*. However, *T. longipetala* differs from *T. elongata* in having flattened leaves, a taller stature and pedicellate flowers in a multi-flowered inflorescence. *Tribonanthes longipetala* is generally found in seasonally wet areas on the slopes of the Darling Scarp, while *T. elongata* is more widespread in winter wet areas throughout the SWAFR. The other significant difference between these two species is that *T. elongata* has fine transparent trichomes on the inside of the stamen connective appendage below the anther, while *T. longipetala* has glabrous stamen connective appendages. On the specimen sheet CGE 06824 the left-hand specimen of *T. longipetala* is designated the lectotype of the species, as indicated on a determinavit slip by A.S. George 15 August 1968. T.D. Macfarlane examined the specimen in 1984, noted that George's lectotypification was never published, but evidently chose not to lectotypify the species. We lectotypify the species here to put typification beyond doubt, in view of the frequency of mixed taxa in collections of this genus.

4. *Tribonanthes monantha* E.J.Hickman & Hopper, *sp. nov.*

Type: Chingah Hill, east of the intersection of Allsop Road and Depot–Dam Road, 30 km south of Merredin via Merredin–Narembeen Road, Western Australia, 12 September 2014, *E.J. Hickman* 2048 (*holo:* PERTH 08986991; *iso:* CANB).

Illustrations: nil other than those herein.

Herb annually renewed from a white ovoid corm, 5–21 cm tall, consisting of a single stem and single leaf. *Corms* 6.0–6.9 mm diameter, covered by numerous old brown, papery sheaths, 2.3–5.2 cm below surface. *Roots* white, with long white root trichomes, no sand-binding rhizosheath. *Aerial stem* (between basal leaf and inflorescence bract) 1–18.5 cm, glabrous. *Basal leaf* 3.2–15.6 cm long, spreading or erect, stem-clasping at base, red-purple, becoming terete, green, with mucronate tip, glabrous. *Inflorescence bract* 9–50 mm long, erect, funnel-like sheath with broad dilated mouth, 4–9 mm circumference at widest point, purple tending to green with three darker longitudinal stripes, punctulate, glabrous surface, membranous margins, no fringing trichomes, terete at top for 1–30 mm, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 2–56 mm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 6–12 mm long, 3.5–7 mm wide, ovate, green-purple, broad membranous margins, fringed with

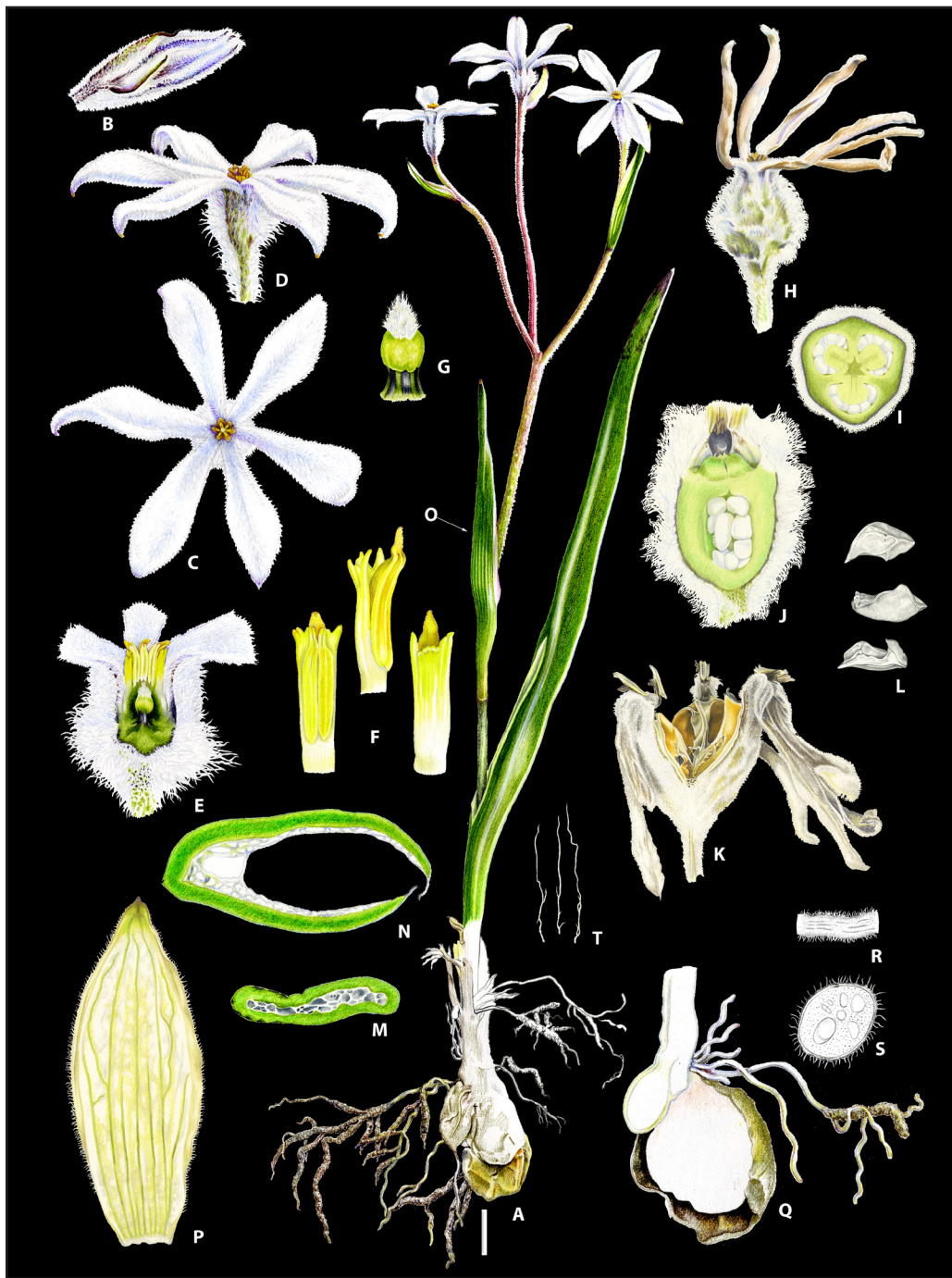


Figure 12. *Tribonanthes longipetala*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing yellow stamen connective appendages shorter than anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of silky white trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes (scale bar = 0.4 mm). Scale bars = 1 cm (A, O); 4 mm (B, C, D, H); 2.5 mm (E, N, P); 1 mm (F, G, N, L); 2 mm (I, J, K, M, R); 0.5 mm (L, S); 5 mm (Q); 0.4 mm (T). Drawn from fresh material E.J. Hickman 2021 (PERTH 08989400). Illustrations by E.J. Hickman.

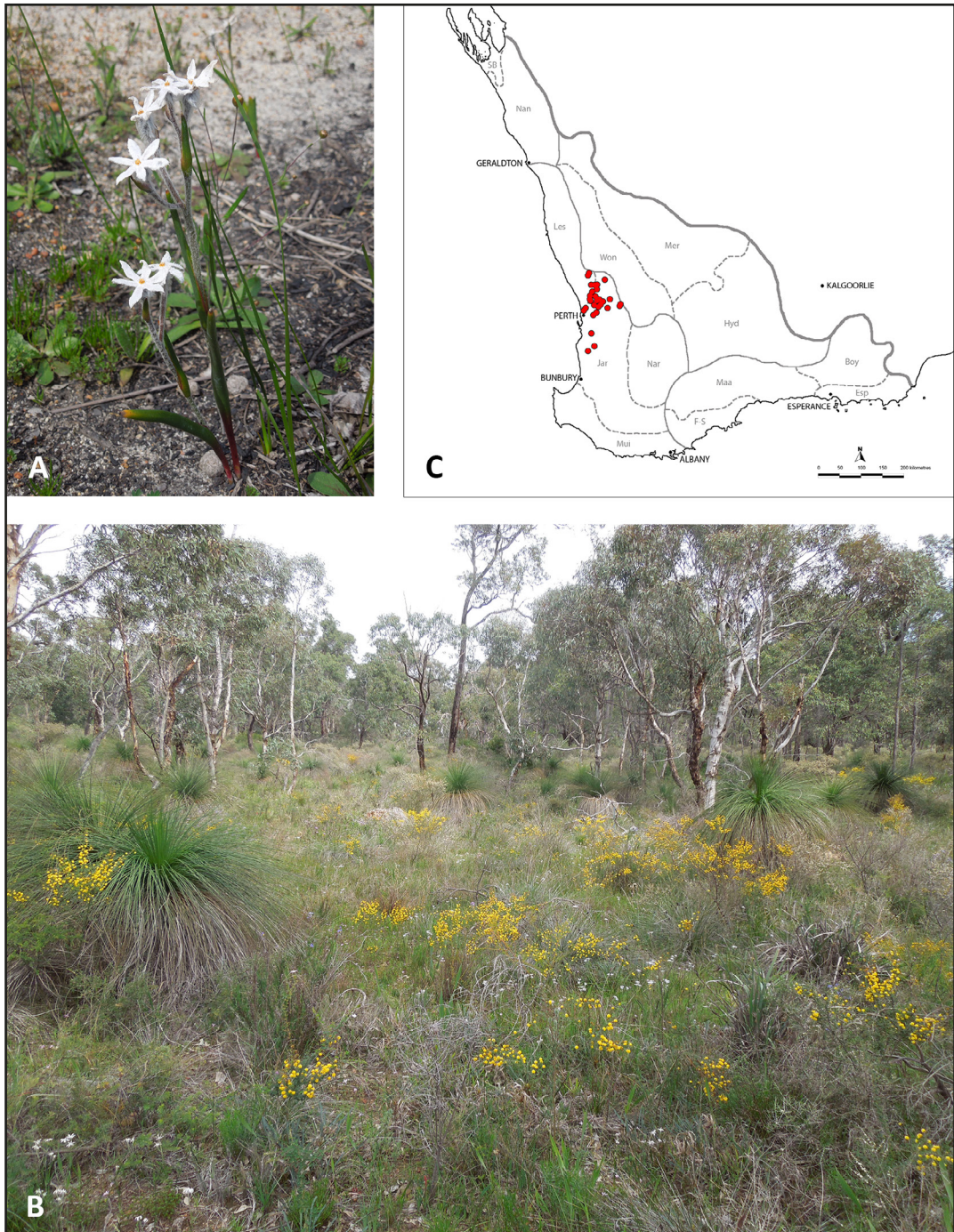


Figure 13. *Tribonanthes longipetala*. A – group of plants each with a multi-flowered inflorescence, (E.J. Hickman 2020); B – habitat (E.J. Hickman 2021), open *Eucalyptus wandoo* woodland with understorey shrubs *Acacia pulchella*, *Hakea lissocarpha*, *Hypocalymma angustifolium* and *Xanthorrhoea preissii* over herbs, sedges and grasses in remnant vegetation on the corner of Watsonia Road and Gooseberry Hill Road, Gooseberry Hill, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photo by E.J. Hickman.

fine white trichomes, otherwise glabrous inside and out, apex shortly terete, 0.5–3 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 3–8 mm long, 2–4 mm wide, spreading, dilated, white woolly hairy inside and outside, tinged pale purple when senescing, dark mucronate tips. *Perianth tube* 3–6 mm long, outer surface covered in white woolly trichomes, inner surface green and glabrous. *Stamen connective appendages* relatively large, 1.5–3 mm long, 1.3–1.5 mm wide, creamy white, topped with 4 or 5, round-tipped finger-like projections, extending above anther tips. *Anthers* 1.9–2.5 mm long, yellow, with yellow sterile apex that projects towards centre of flower, attached at base of stamen connective appendage. *Ovary* green, half-inferior, locules 3 with numerous (25) ovules per locule. *Style* short to sub-sessile, 0.4–2 mm long, green with longitudinal purple stripes. *Stigma* capitate, yellow, glandular. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 14, 15)

Diagnostic features. Medium plant, terete leaves, long peduncles, solitary flowered inflorescence, woolly white flowers turning purple at senescence, obvious cream stamen connective appendages, short to almost absent style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: granite slab, South West Highway, 8.6 km S of Weld Rd, 16 Sep. 1994, *A.R. Annels & R.W. Hearn* ARA 4440 (PERTH); Gull Rock Lake, Albany, 30 Sep. 1984, *R.J. Cranfield* 4970 (PERTH); 1.5 km W of SW boundary of Chiddarcooping Nature Reserve, 11 Sep. 1989, *R.J. Cranfield* 7803 (PERTH); Bunny Rd W of Three Springs, 3 Oct. 1990, *R.J. Cranfield & P.J. Spencer* 7953 (PERTH); Grevillea Rock, 12 Aug. 2003, *R.J. Cranfield* 19414 (PERTH); Hillman townsite, NE of Darkan, 15 Sep. 1994, *V. Crowley* DKN 69 (PERTH); Water Reserve Capitella Rd, SE of Dandaragan, 10 Sep. 1988, *E.A. Griffin* 5000 (PERTH); Brixton Street Wetlands, Kenwick, 27 Aug. 2014, *E.J. Hickman* 2024 (PERTH); Munbinea Rd, 10 km south of Bibby Rd, 28 Aug. 2014, *E.J. Hickman* 2027 (PERTH); Old Muntadgin Rd, 3.5 km north of intersection with Briant Rd, 12 Sep. 2014, *E.J. Hickman* 2047 (PERTH); Yelverton State Forest, 2 Oct. 1986, *S.D. Hopper* 5596 (PERTH); Jeegarnyeejip Island, Murray River Delta, 16 Nov. 2000, *G.J. Keighery* 16156 (PERTH); Nullilla Nature Reserve S of Gingin, 14 Sep. 2005, *G.J. Keighery* 16581 (PERTH); Petrudor Rock Reserve, SE of Dalwallinu, Aug. 1984, *N.G. Marchant s.n.* (PERTH); Wongan Hills, 10 Sep. 1962, *F.W. Went* 160 (PERTH).

Proposed vernacular name. Widespread Tiurndin.

Phenology. Flowers from August to September.

Distribution and habitat. *Tribonanthes monantha* is known from scattered locations along the coast and inland from Arrowsmith in the north to Albany in the south and to Chiddarcooping Nature Reserve, north-east of Merredin. Populations are located within the Lesueur, Jarrah and Muir Districts of the Bibbulmun Province and Wongan, Merredin and Hyden Districts of the Transitional Rainfall Province of south-west Western Australia (Gioia & Hopper 2017). *Tribonanthes monantha* grows on a variety of soil types from sandy clays to loams as well as peat, associated with granite and laterite. These areas are winter wet depressions, flats, drainage-lines or swamps supporting shrublands, herbfields or samphire with associated species including *Acacia acuminata*, *Casuarina obesa*, *Melaleuca viminea*, *M. uncinata*, *M. lateriflora*, *Tecticornia indica* and *T. halocnemoides* (Figure 15).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Greek *monos* (alone or solitary) and *anthos* (flower), referring to the single flower of this species.

Notes. *Tribonanthes monantha* collections have previously been identified as belonging to *T. australis*, *T. longipetala* and *T. violacea*. *Tribonanthes monantha* resembles *T. australis* in having horizontally spreading perianth lobes covered on both sides in white woolly trichomes and having a conspicuous corona-like structure of creamy white stamen connective appendages exceeding the anther tips. However, *T. monantha* differs from *T. australis* in having a smaller habit and smaller single-flowered inflorescence, with inflorescence bracts having distinct broad membranous glabrous margins instead of hairy margins. The perianth lobes of *T. monantha* are broader relative to their length than those of *T. australis*. *Tribonanthes monantha* differs from *T. longipetala* in having shorter perianth lobes and cream (not bright yellow) stamen connective appendages. *Tribonanthes monantha* differs from *T. violacea* in having an obvious peduncle, which is covered in woolly trichomes from the inflorescence bract to the first floral bract. *Tribonanthes monantha* is distinctly different to *T. minor* in having spreading rather than strongly reflexed perianth lobes and having creamy-white rather than yellow staminal appendages. *Tribonanthes monantha* is similar to *T. uniflora* in its small to medium stature and single-flowered habit but differs in having an inflorescence bract with a broader membranous margin and no fringing hairs and the flowers of *T. monantha* turn purple at senescence while *T. uniflora* flowers remain white.

5. *Tribonanthes porphyrea* E.J.Hickman & Hopper, *sp. nov.*

Type: Bashford Nature Reserve, south-east corner of reserve in claypan, off Bootoo Road, east of Indian Ocean Drive, Western Australia, 28 August 2014, *E.J. Hickman* 2025 (*holo:* PERTH 08986959, *iso:* CANB).

Illustrations. Nil other than those herein.

Herb annually renewed from a white ovoid corm, 10.4–30.5 cm tall above ground, consisting of a single stem and single leaf. *Corms* 3.8–6.2 mm diameter, covered by numerous old brown, papery sheaths, 2–7.7 cm below soil surface. *Roots* white, with white rootlets, no sand-binding rhizoseath. *Aerial stem* (from basal leaf to inflorescence bract) 6.5–27 cm, glabrous. *Basal leaf* 8.8–20 cm long, attached to aerial stem 0–7.5 cm above ground, erect, sheath stem-clasping, green, lamina filiform to sub-terete, glabrous. *Inflorescence bract* 1–7.1 cm long, erect, funnel-like sheath with broad dilated mouth, 4–8 mm circumference at widest point, green, the membranous margin tinged purple and fringed with fine white trichomes; lamina 4–90 mm long, terete, green, glabrous, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 0.1–11 cm long, sparsely hairy. *Inflorescence* a solitary flower, subtended by one or two floral bracts. *Floral bract* 8–19 mm long, 4–8 mm wide, oval, green with membranous margin fringed with white trichomes and scattered trichomes on the base, apex 1–9 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 6.4–15 mm long, 2.1–5 mm wide, spreading, inner surface white velvety hairy, outer surface deep purple sparsely hairy. *Perianth tube* 3.3–7.1 mm long, pale green to white, inner surface glabrous, outer surface woolly hairy. *Stamen connective appendages* 2–4 mm long, 1.5–2.1 mm wide, cream, tips rounded with some small scattered purple spots, exceeding anther tips. *Anthers* 2.5–4 mm long, yellow, with elongated cream sterile apex that projects upwards, attached centrally on stamen connective appendages. *Ovary* green, half-inferior, locules 3 with many (78) ovules per locule. *Style* 0.7–2 mm long, green. *Stigma* capitate, yellow, with elongated tip covered in short trichomes and three glandular protuberances on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 16, 17)

Diagnostic features. Tall plant, filiform to sub-terete leaf often sub-basal, short peduncles, solitary flowered inflorescence, velvety white flowers with deep purple outer surface and broad perianth lobes,

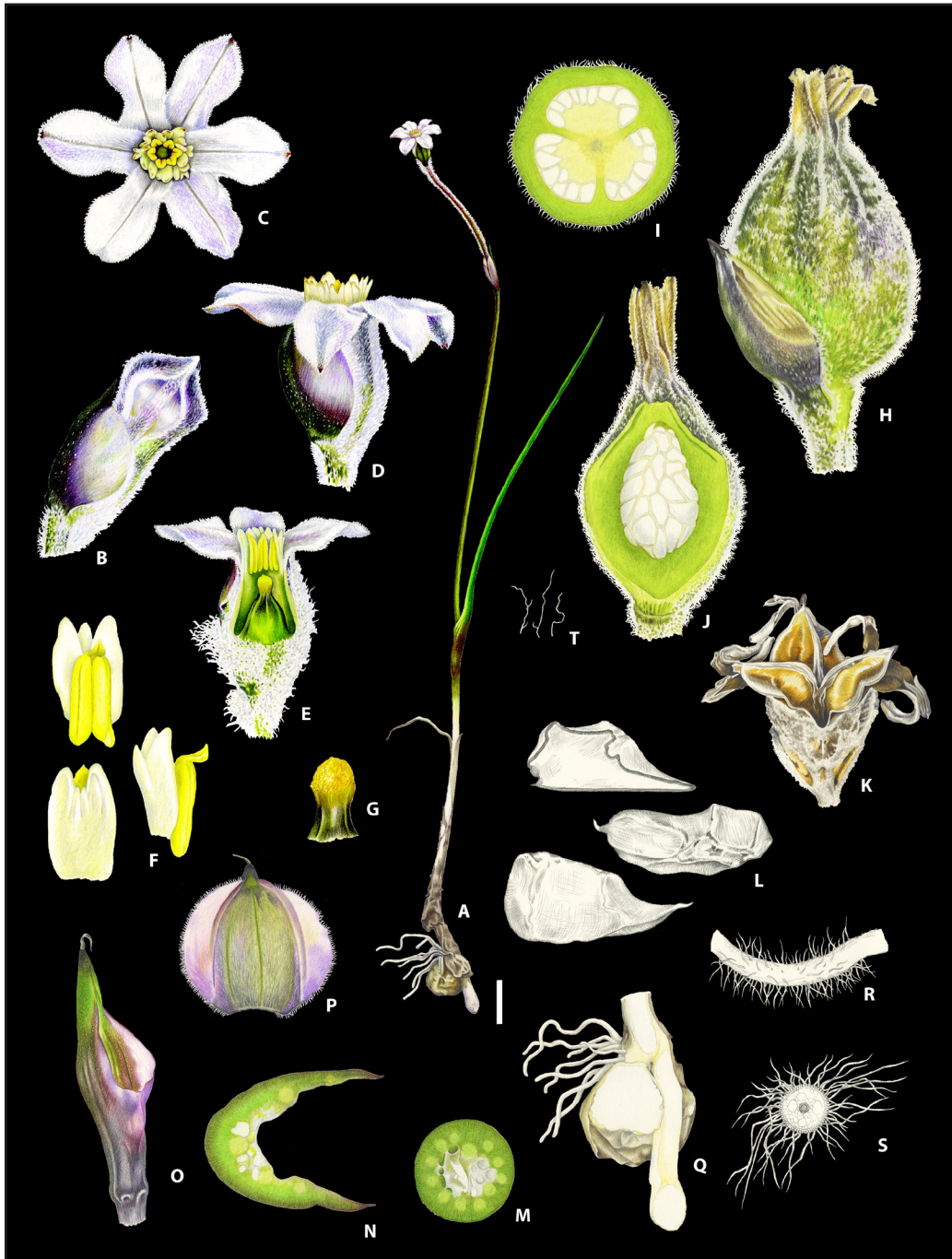


Figure 14. *Tribonanthes monantha*. A – whole plant; B – bud; C – flower from top showing short broad perianth lobes; D – flower from side showing floral bract with broad scarious margin and coronet of filament appendages; E – flower with part of perianth removed to show ovary and style; F – anthers from front, back and side view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting forwards; G – style sub-sessile with simple stigma; H – capsule; I – cross section through capsule; J – longitudinal section through capsule; K – dehiscent capsule; L – seed; M – leaf cross section near apex; N – leaf cross section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2 mm (B, C, D, E, H, I, J, K, O, P); 0.8 mm (F, G); 1 mm (L); 0.65 mm (M, N); 4 mm (Q); 1.25 mm (R); 0.5 mm (S, T). Drawn from fresh material E.J. Hickman 2048 (PERTH 08986991). Illustrations by E.J. Hickman.

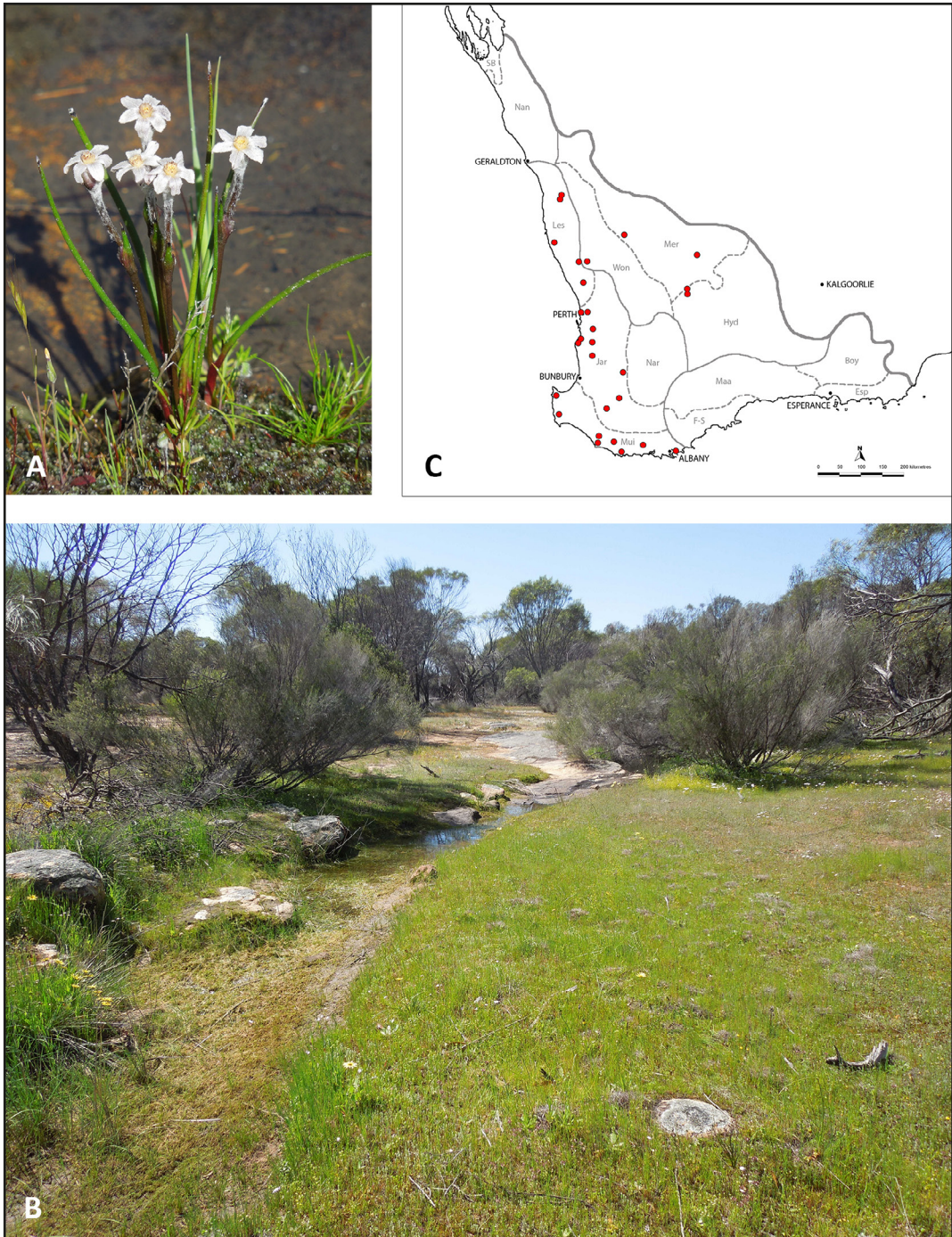


Figure 15. *Tribonanthes monantha*. A – group of plants each with a single-flowered inflorescence with cream stamen connective appendages and spreading perianth lobes covered in woolly white trichomes, (E.J. Hickman 2048); B – habitat (E.J. Hickman 2048), herbfield and fringing shrubland along a drainage-line at the base of Chingah Hill, a granite hill south-east of Merredin, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

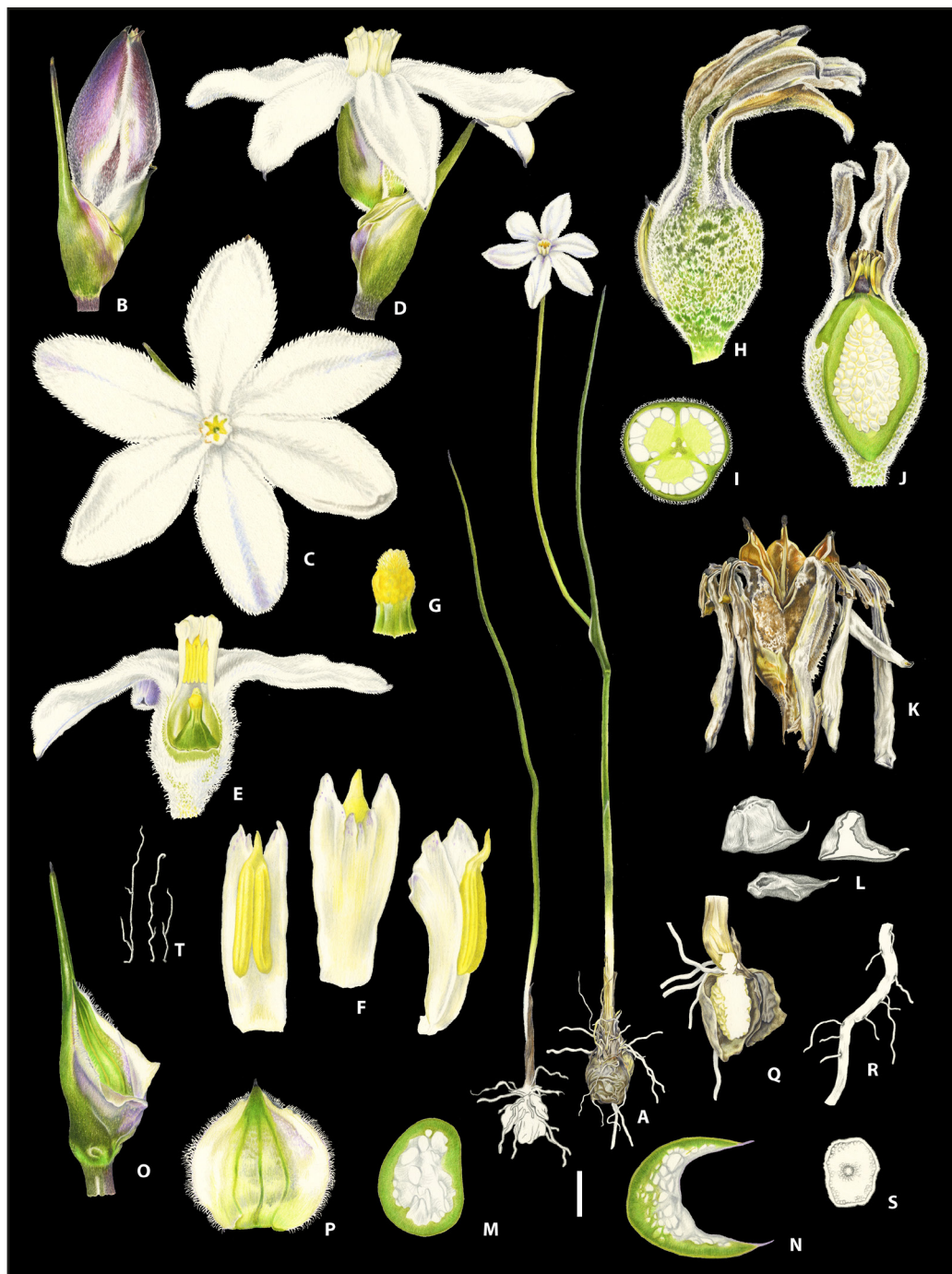


Figure 16. *Tribonanthes porphyrea*. A – whole plant flowering and non-flowering; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, back and side view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, H, I, J, K, O, P, R); 1 mm (F, G); 0.5 mm (L); 0.65 mm (M, N, T); 4 mm (Q); 0.4 mm (S). Drawn from fresh material E.J. Hickman 2025 (PERTH 08986959). Illustrations by E.J. Hickman.

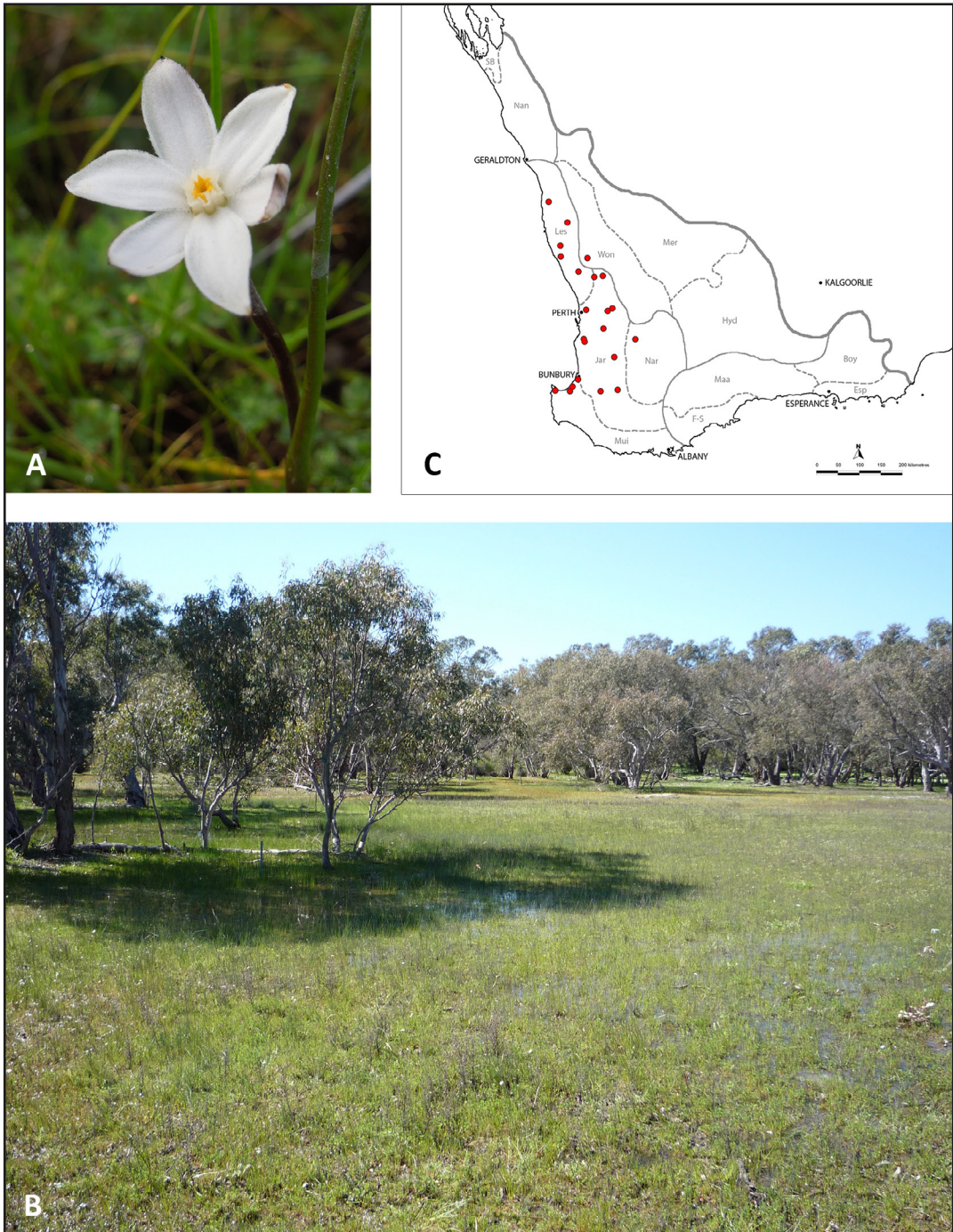


Figure 17. *Tribonanthes porphyrea*. A – single-flowered inflorescence with cream stamen connective appendages and spreading perianth lobes covered in silky white trichomes on inner surface and sparsely hairy on outer surface (E.J. Hickman 2025); B – habitat (E.J. Hickman 2025), water-logged herbfield in a winter wet depression, fringed by *Eucalyptus rudis* woodland, Bashfords Nature Reserve, north-east of Lancelin, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

obvious cream stamen connective appendages, short style, stigma with tuft of short trichomes and three glandular protuberances, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Lake Wannamal Nature Reserve, 1 km E of Bindoon–Moora Rd, 9 Sep. 2014, *K.L. Brown* 1149 (PERTH); Julimar State Forest, 2 km S of Bindoon–Dewars Pool Rd, 10 Sep. 2014, *K.L. Brown et al.* KLB 1151 (PERTH); Drummond Nature Reserve, 10 Sep. 2014, *K.L. Brown et al.* KLB 1152 (PERTH); Little Darkin Swamp, Wandoo National Park, 26 Nov. 2005, *A. Crawford* ADC 991 (PERTH); Cell 10, Hartwood Rd, NW of Boyup Brook, 28 Oct. 1998, *R. Davis* 8086 (PERTH); Pinjarra Nature Reserve, 6 Aug. 2007, *P. Foreman & J. Kelly* PJ 510 (PERTH); Drummond Nature Reserve, 12 Oct. 1998, *N. Gibson* 4317 (PERTH); Popanyinning, 22 Sep. 1996, *A.G. Guinness et al.* POPO 19/29 (PERTH); Leda Nature Reserve, 3.3 km S of Beekeepers Rd, 5.8 km W of Brand Hwy, 20 Aug. 2014, *E.J. Hickman* 2013 (PERTH); Brixton Street Wetlands, Alton St, walktrail into claypan, 4 Sep. 2014, *E.J. Hickman* 2045 (PERTH); Ambergate Regional Park, S of Busselton, SW of intersection of Doyle Rd and Queen Elizabeth Ave, 16 Aug. 2016, *E.J. Hickman* 2088 (PERTH); 5 km E of Quindanning to Williams, 26 Sep. 1987, *G.J. Keighery* 9166 (PERTH); Simmonds Block, Tuart Forest 15 Sep. 1994, *G.J. Keighery* 15005 (PERTH); Gillingarra Nature Reserve, 18 Sep. 2008, *G.J. Keighery* 17327 (PERTH); Lower Canning River, 28 Sep. 1898, *A. Morrison* 8276 (PERTH); Meelup Reserve, Dunsborough, 5 Sep. 2006, *R. Watkins* BNC 1014 (PERTH).

Proposed vernacular name. Purple-budded Tiurndin.

Phenology. Flowers from August to November.

Distribution and habitat. *Tribonanthes porphyrea* is known from scattered locations along the coast and inland from Eneabba in the north to Boyup Brook in the south and east to Popanyinning. Populations are located within the Lesueur, Jarrah, Muir and Narrogin Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), with a single population known from the western edge of the Wongan District of the Transitional Rainfall Province (PERTH 08504083). *Tribonanthes porphyrea* grows on brown to grey clays and sandy clays as well as peat, in standing water of winter wet depressions, flats, claypans and swamps, supporting open woodland, shrublands, herbfields or sedgeland with associated species including *Eucalyptus rudis*, *E. wandoo*, *Corymbia calophylla*, *Melaleuca viminea*, *M. lateritia*, *M. uncinata*, *M. raphiophylla*, *Viminaria juncea*, *Acacia acuminata*, *Astartea affinis*, *Chorizandra enodis*, *Eleocharis keigheryi*, *Leptocarpus coangustatus* and *Liparophyllum capitatum* (Figure 17).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Greek *porphyreos* (purple), referring to the distinct purple backs of the perianth lobes.

Notes. *Tribonanthes porphyrea* has been most often misidentified as *T. longipetala*, probably due to its relatively large and long perianth lobes. It differs from *T. longipetala* in having cream stamen connective appendages rather than yellow stamen connective appendages, a single-flowered inflorescence, velvety white trichomes on the inner surface of the perianth lobes and deep purple, sparsely hairy outer perianth lobes, rather than the silky white trichomes that cover both inner and outer surface of the perianth lobes of *T. longipetala*, and a short peduncle. It is similar to *T. longipetala* in having a tuft of silky white trichomes on top of the stigma. *Tribonanthes porphyrea* has also been misidentified as *T. violacea* probably due to the deep purple colouration of the outer surface of the perianth lobes

and the tendency of the plants to turn purple as they senesce. It differs from *T. violacea* in having a prominent crown of stamen connective appendages, rather than the small to residual stamen connective appendages of *T. violacea*. Most *Tribonanthes* species have their point of basal leaf attachment to the aerial stem at or just below the soil surface. *Tribonanthes porphyrea* differs in sometimes having its point of leaf attachment above the soil surface to a height of 75 mm (Figure 16). As this species is often growing in standing water this extension of the aerial stem, below the point of leaf attachment, may be a mechanism to keep its 'head above water'.

6. *Tribonanthes elongata* E.J.Hickman & Hopper, *sp. nov.*

Type: Watershed Road, 4.5 km north of intersection with Basin Road, south-east side of road on wet flat, Mount Romance area of State Forest, north-west of Denmark, Western Australia, 3 November 2014, E.J. Hickman 2073 (*holo*: PERTH 08986967; *iso*: CANB).

Illustration. M. Corrick, *Wildflowers of southern W. Austral.* p. 86 (1996) (as *T. australis*).

Herb annually renewed from a white ovoid corm, 8.5–16.7 cm tall above ground, consisting of a single stem and single leaf. *Corms* 10–15 mm diameter, covered by numerous old brown, papery sheaths, 1.7–5.7 cm below soil surface. *Roots* white, with a few scattered small white root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf and inflorescence bract) 2–8.8 cm, lower 3/4 glabrous, the remainder with a few trichomes. *Basal leaf* 3.6–18.4 cm long, erect, the stem-clasping base red-purple grading to green with darker green longitudinal striations and red margin, top becoming terete with a mucronate tip, glabrous. *Inflorescence bract* 1.2–4.8 cm long, erect, the stem-clasping base 5–8 mm circumference at widest point, red-purple base grading to green with darker green longitudinal striations and red to purple margins with no fringing trichomes; lamina 3–23 mm long, terete, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 2.6–8.7 cm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 8–17 mm long, 3–8 mm wide, lanceolate, green, with prominent longitudinal veins, membranous, with hairy margins, hairy at base of outside surface, glabrous inside surface, apex shortly terete, 1–3 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 8–14 mm long, 2–5 mm wide, spreading to recurved, oblong, white velvety hairy inner and outer surfaces, with purple tinge along midline of outer surface, dark mucronate tip. *Perianth tube* 4–7.9 mm long, outer surface covered in white silky trichomes forming a distinct skirt at the base, inner surface pale green, glabrous. *Stamen connective appendages* small, 1.1–2.6 mm long, 1.1–1.3 mm wide, yellow, topped with 5 short pointed tips, their apices below anther tips, transparent trichomes on inner surface below anther. *Anthers* 2.5–3.9 mm long, yellow, with a deep yellow sterile apex that projects slightly towards centre of flower, attached centrally on stamen connective appendage. *Ovary* green, inferior, locules 3 with several (26) ovules per locule. *Style* short to almost absent, 0.4–1.5 mm long, with green and purple longitudinal striations. *Stigma* capitate, green, with prominent tuft of white silky trichomes on top. *Capsule* greyish brown; perianth persistent; lobes spreading before dehiscence, more reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 18, 19)

Diagnostic features. Medium plant, terete leaf, long peduncle, solitary flowered inflorescence, velvety white flowers with long narrow perianth lobes, small yellow stamen connective appendages, short to sub-sessile style, stigma with prominent tuft of silky white trichomes on top, inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: 10 km SW of Goomalling on Goomalling–Toodyay Rd, 31 Aug. 1993, P. Armstrong *s.n.* (PERTH); Parkerville, 5 Sep. 1976, R. Coveny 8058



Figure 18. *Tribonanthes elongata*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from back, front and side view showing yellow stamen connective appendages shorter than anthers, fine trichomes on filaments below anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of silky white trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 4 mm (B, C, D, Q); 2.5 mm (E, H, I, J, K, O, P); 1 mm (F, G, L, M, N, R); 0.5 mm (S); 0.65 mm (T). Drawn from fresh material E.J. Hickman 2073 (PERTH 08986967). Illustrations by E.J. Hickman.

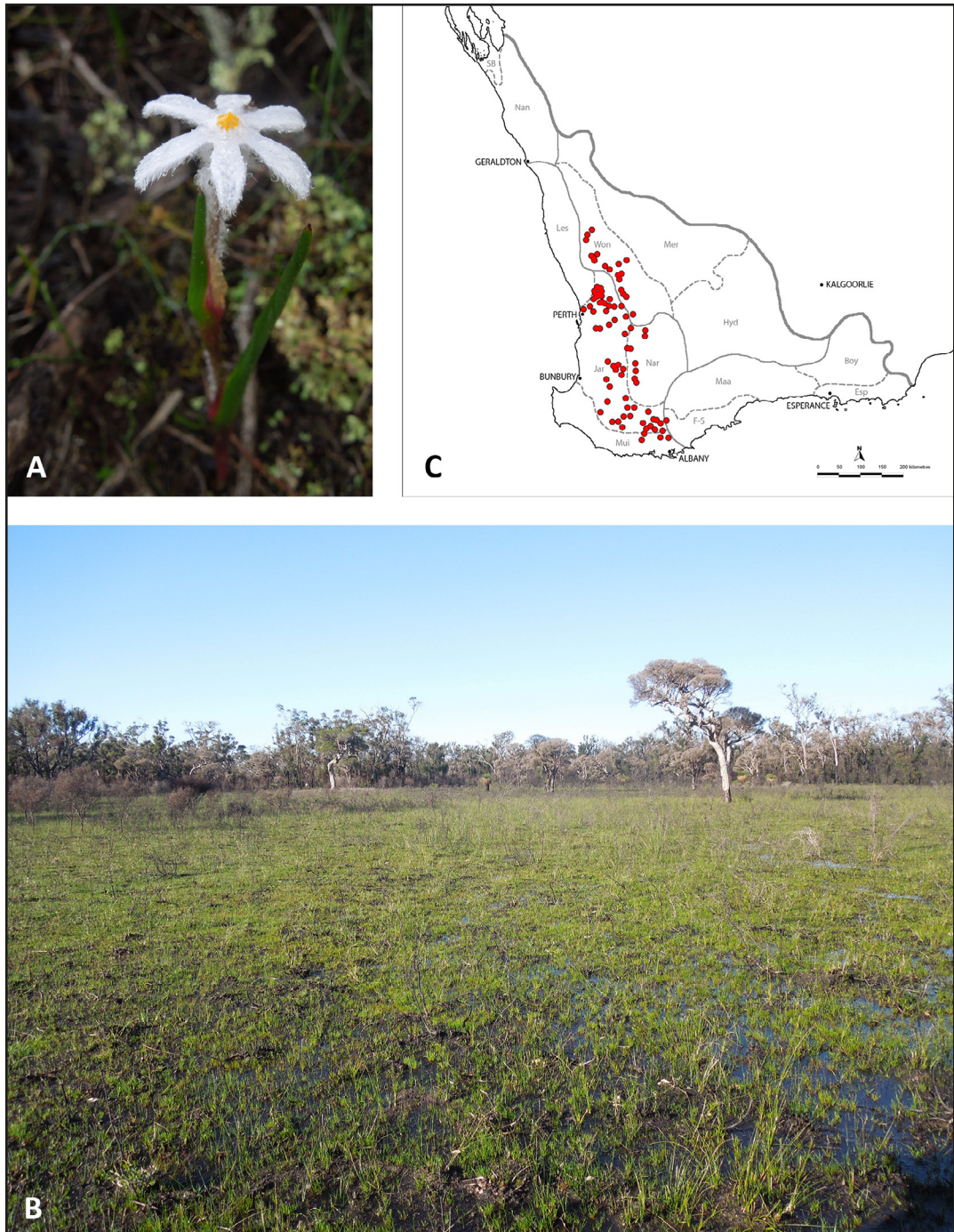


Figure 19. *Tribonanthes elongata*. A – single-flowered inflorescence with white woolly hairy spreading perianth lobes, and yellow stamen connective appendages (E.J. Hickman 2073); B – habitat (E.J. Hickman 2073), burnt, seasonal wet flat, dominated by *Melaleuca* spp. shrubland, surrounded by Jarrah/Marri woodland, on Watershed Road, Mt Romance area of the state forest, north-west of Denmark, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

(PERTH); Moorialup Rd, E of Porongurups, 30 Aug. 1983, *D. Davidson s.n.* (PERTH); Jingaring Reserve, ESE of Brookton, 1 Sep. 1998, *R. Davis* 6527 (PERTH); Hillman Forest Block, 27 Sep. 2006, *S. Fisher* BNC 1070 (PERTH); Beaufort River Bridge Nature Reserve, N of bridge, E of Albany Hwy, 18 Aug. 2014, *E.J. Hickman* 2012 (PERTH); Northam–Pithara Rd, 400 m S of Konnongorring West Rd, E side of road at base of W sloping sheet of granite, 11 Sep. 2014, *E.J. Hickman* 2046 (PERTH); Nollajup Nature Reserve, Jayes Rd, 11.5 km E from Bridgetown–Boyup Brook Rd, N side of road around granite outcrop, 20 Sep. 2014, *E.J. Hickman* 2058 (PERTH); Mettabinup Nature Reserve, 3.3 km W on Flora and Fauna Rd from Tone Rd, then 500 m W into reserve to the SW boundary, 20 Sep. 2014, *E.J. Hickman* 2059 (PERTH); reserve on Frankland–Cranbrook Rd, 100 m N on Addis Rd from Frankland–Cranbrook Rd, 20 Sep. 2014, *E.J. Hickman* 2063 (PERTH); Wamballup Lake Nature Reserve, 500 m W on Wamballup Rd from Boyup Rd, S side of road in broad drainage line, 30 Sep. 2014, *E.J. Hickman* 2064 (PERTH); Mokine Nature Reserve, WSW of Northam, 2 Aug. 1985, *G.J. Keighery* 7794 (PERTH); Lake Muir Nature Reserve, NE side of Lake Muir, 27 Aug. 1998, *G.J. Keighery* 15411 (PERTH); Poison Paddock, New Norcia, 5 Aug. 2004, *K. Macey* 594 (PERTH); 14 km N of Moora from Moore River Bridge, along road to Geraldton, 27 July 1982, *T.D. Macfarlane* 856 (PERTH); Mount Hardey Reserve, 19 Aug. 1998, *J. Monks* JM 108 (PERTH); Beverley Airfield Reserve, 27 Sep. 2000, *M. Ochtman* BAR 109 (PERTH); Dryandra State Forest, 30 Aug. 1988, *D. Rose* 669 (PERTH); Sullivan Rock S of Armadale, 30 Aug. 1992, *P.J. Rudall* 20 (PERTH); 21 km from Collie towards Darkan, 22 Sep. 1983, *J. Taylor & P. Ollerenshaw* JT2101 (PERTH); Reserve 424A, Talbot West Road, York, 9 Aug. 2003, *C. & A. Warburton* AW 27 (PERTH); Highbury Block State Forest, 15 Oct. 1999, *G. Warren, C. Taylor & P. Rose* 315 (PERTH).

Proposed vernacular name. Brilliant-flowered Tiurndin.

Phenology. Flowers from August to October.

Distribution and habitat. *Tribonanthes elongata* is known from Watheroo in the north to the Porongurup Range in the south and from Perth east of the Darling Scarp to Pingelly. Most populations occur within the Jarrah, Narrogin and Muir Districts of the Bibbulmun Province and Wongan District of the Transitional Rainfall Province of south-west Western Australia, but one population is on the border of the Jarrah District of the Bibbulmun Province and the Fitzgerald-Stirling District of the Southeast Coastal Province (Gioia & Hopper 2017). *Tribonanthes elongata* grows on brown to grey sandy loam to sandy clay, on winter wet flats and at the base of granite outcrops that support open woodlands, shrublands and herbfields. Associated species include *Eucalyptus rudis*, *E. wandoo*, *E. loxophleba*, *E. marginata*, *E. occidentalis*, *Corymbia calophylla*, *Allocasuarina* spp., *Melaleuca preissiana*, *M. viminea*, *Hakea* spp., *Acacia acuminata* and various herbs and sedges (Figure 19).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin *elongatus* (elongated), referring to the long perianth lobes of this species.

Notes. Based on determinations on herbarium specimens, Macfarlane (1987) included our *Tribonanthes elongata* in his concept of *T. longipetala*. However, *T. elongata* differs from *T. longipetala* in having terete leaves, a smaller stature and a single-flowered inflorescence. *Tribonanthes elongata* also has a more widespread distribution, in winter wet areas throughout the SWAFR, while *T. longipetala* is generally found in seasonally wet areas on the slopes of the Darling Scarp. The other significant difference between these two species is that *T. elongata* has fine transparent trichomes on the inside of the filament below the anther, while *T. longipetala* has glabrous filaments.

7. *Tribonanthes keigheryi* E.J.Hickman & Hopper, *sp. nov.*

Type: Wamballup Lake Nature Reserve, 500 m west along Wamballup Road from Boyup Road, south side of road in broad drainage line, Western Australia, 30 September 2014, *E.J. Hickman* 2065 (*holo:* PERTH 08986940; *iso:* CANB).

Tribonanthes sp. Lake Muir (G.J. Keighery & N. Gibson 2134), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 1 Feb. 2019].

Illustration. Nil other than those herein.

Herb annually renewed from a white ovoid corm, 3.0–26.5 cm tall above ground, consisting of a single stem and single leaf. *Corms* 6.4–6.8 mm diameter, covered by numerous old brown, papery sheaths, 1.5–4.6 cm below soil surface. *Roots* white, with no root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 2–23 cm, glabrous. *Basal leaf* 4.4–17.5 cm long, erect, stem-clasping to filiform, deep red-purple base grading to green, glabrous, with mucronate tip. *Inflorescence bract* 0.8–6.1 cm long, erect, funnel-like sheath with broad dilated mouth, 4–9 mm circumference at widest point, green with broad transparent membranous margins, sometimes tinged pink, fringed at top with fine white trichomes; lamina 5–44 mm long, filiform, green, glabrous, with a dark mucronate tip. *Peduncle* (from inflorescence bract to floral bract) absent, or if present to 0.7 cm long, with very few scattered trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 4–11 mm long, 1.5–6 mm wide, orbicular to ovate, green with broad membranous margin tinged pink and fringed with white trichomes, otherwise glabrous, apex 0.5–3 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 3–6 mm long, 1.5–3 mm wide, spreading to erect, obovate, inner surface white woolly hairy, on outer surface sparsely hairy with broad central purple or green stripe. *Perianth tube* 2.5–5 mm long, outer surface green with few scattered white trichomes, inner surface white and glabrous. *Stamen connective appendages* small to residual 0–1.5 mm long, 0.7 mm wide, white with purple tinged spot where anther attaches, two pointed tips, their apices below anther tip. *Anthers* 0.7–2 mm long, yellow, with small paler yellow sterile apex that projects upwards, attached at top of the stamen connective appendage. *Ovary* green, half-inferior, locules 3 with several (14) ovules per locule. *Style* relatively long, 0.7–2.5 mm, green. *Stigma* capitate, yellow, with few short trichomes on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 20, 21)

Diagnostic features. Medium plant, filiform leaf, short peduncles, solitary-flowered inflorescence, woolly white flowers with purple sparsely hairy outer surfaces, small to residual white stamen connective appendages, long style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERNAUSTRALIA: Kangaroo Rd, 4.1 km E of Collis Rd, 14 Sep. 1994, *A.R. Annels* & *R.W. Hearn* ARA 4416 (PERTH); Wandoo Conservation Park, Goonapping Swamp, 17 Sep. 2014, *K.L. Brown* & *G. Paczkowska* KLB 1154 (PERTH); Brockman Highway, 6 Oct. 2000, *R. Cranfield* 15475 (PERTH); Coalfields Rd, 4 km NE of Bowelling, 25 Sep. 1995, *V. Crowley* DKN 70 (PERTH); King George Sound, 1 Dec. 1900, *Col. Goadby* B2063 (PERTH); Lake Muir Nature Reserve, 5.9 km W of Unicup Rd on Muirs Hwy, 60 m S of road side, 17 Oct. 2013, *E.J. Hickman* 2001 (PERTH); Kulunilup Nature Reserve, 2.3 km S of Wingebellup Rd on Unicup Rd, E side of road, 17 Oct. 2013, *E.J. Hickman* 2002 (PERTH); Cobertup Nature Reserve, 2.5 km N on Noobijup Rd from Muirs Hwy, 400 m W along N boundary firebreak, 17 Oct. 2013, *E.J. Hickman* 2004 (PERTH); Wimballup Swamp, NW side, 3.8 km W of Frankland River bridge, 2.9 km S on track to

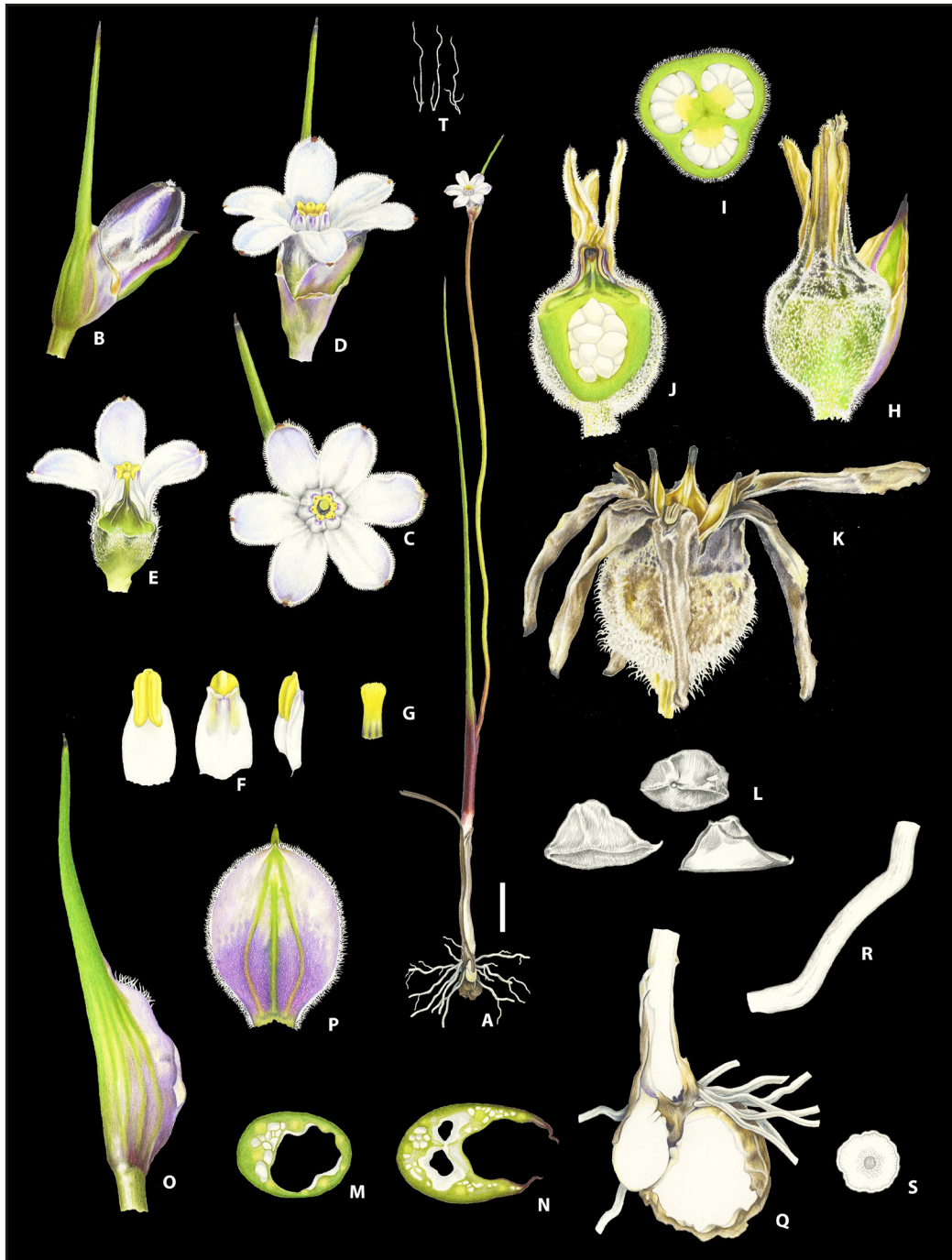


Figure 20. *Tribonanthes keigheryi*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, back and side view showing stamen connective appendages scarcely developed, much shorter than anthers and yellow anthers without prominent apiculate apex; G – style elongated with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex (hollow); N – leaf section near base (hollow); O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, O, P, Q); 1 mm (F, G, L); 2 mm (H, I, J, K); 0.65 mm (M, N); 1.25 mm (R); 0.5 mm (S); 0.4 mm (T). Drawn from fresh material E.J. Hickman 2065 (PERTH 08986940). Illustrations by E.J. Hickman.

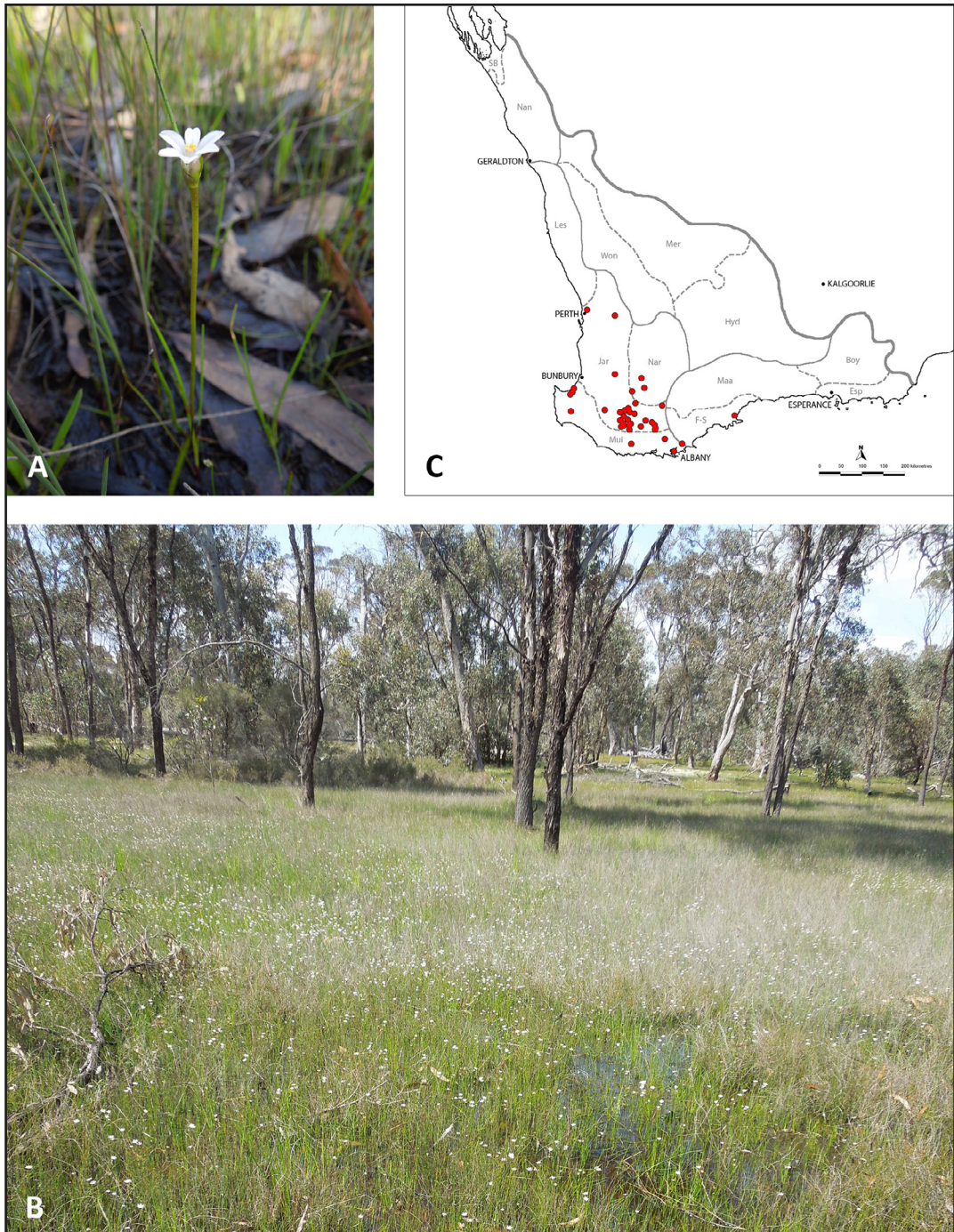


Figure 21. *Tribonanthes keigheryi*. A – small single-flowered inflorescence with white woolly hairy spreading perianth lobes, and minute stamen connective appendages (E.J. Hickman 2065); B – habitat (E.J. Hickman 2065), seasonally wet flat, in open *Eucalyptus occidentalis* and *E. rudis* woodland, Wamballup Lake Nature Reserve, west of Kendenup; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Neerabup Rd, 5.5 km W to site, 23 Oct. 2013, *E.J. Hickman* 2005 (PERTH); Cannington, 28 July 1973 *G.J. Keighery* 366 (PERTH); 1 km S of Tambellup to Cranbrook, 20 Oct. 1983, *G.J. Keighery* 6715 (PERTH); Beaufort River Water Reserve, 7 Oct. 2003, *G.J. Keighery* 16357 (PERTH); Yoongarillup Townsite Reserve, SE of Busselton, 15 Sep. 2006, *G.J. Keighery* 17045 (PERTH); South West Hwy, 6.5 km N of Palgarup, 12 Oct. 1983, *T.D. Macfarlane* 1244 (PERTH); Tooregullup Swamp, 15 km NE of Bremer Bay, 25 Sep. 1976, *K.R. Newbey* 4987 (PERTH); Wandoo National Park, 4 Oct. 2007, *M. Wheeler, P. Armstrong & students* 480 (PERTH).

Proposed vernacular name. Keighery's Tiurndin.

Phenology. Flowers from August to October.

Distribution and habitat. The distribution of *T. keigheryi* is broadly scattered from Perth to north-east of Bremer Bay, but the majority of populations are located around the wetlands and swamps between Manjimup and Mt Barker, where the plants are often in standing water. Populations are concentrated in the Jarrah and Muir Districts of the Bibbulmun Province of the south-west of Western Australia (Gioia & Hopper 2017), but also occur in the Narrogin District of the Bibbulmun Province, and Fitzgerald–Stirling District of the Southeast Coastal Province. *Tribonanthes keigheryi* grows on grey to brown sand, sandy clay or clay, in the winter wet flats, valley floors and wetlands that support open woodlands, and sedgeland. Associated species include *Eucalyptus rudis*, *E. wandoo*, *E. occidentalis*, *Corymbia calophylla*, *Melaleuca raphiophylla*, *M. cuticularis*, *M. viminea*, *M. lateritia*, *Hakea prostrata*, *H. varia* *Callistemon phoeniceus*, *Hypocalymma angustifolium*, *Chorizandra enodis*, *Leptocarpus* spp., *Ornduffia submersa* and *Pauridia* spp. (Figure 21).

Conservation status. Widespread with no special conservation needs. When first recognised, *T. keigheryi* was listed as Priority Three (Smith & Jones 2018). However, in light of the present study, this species has been shown to be widespread with no special need for conservation and it has consequently been de-listed.

Etymology. Named for Gregory J. Keighery, survey botanist with the Department of Conservation and Land Management and its successors, for his many contributions to the study of Western Australian flora and vegetation. Greg has an encyclopaedic knowledge of plant names and has become one of the most prolific collectors of Western Australian plants, as well as naming more than 100 new species. The specific epithet is pronounced 'key-er-ee-eye'.

Notes. *Tribonanthes keigheryi* differs from *T. violacea* in having a slenderer habit and smaller flowers. This difference was noted by Greg Keighery with specimens he first collected in 1997 and lodged at the Western Australian Herbarium with the designation *Tribonanthes* sp. Lake Muir.

8. *Tribonanthes variabilis* Lindl., *Sketch Veg. Swan R.* xlv (1840).

Type: Damp places, The Vasse, Western Australia, *Mrs Molloy p.p.* (*lecto*: CGE23342! all plants except second from the left, *fide* T.D. Macfarlane, *Fl. Australia* 45: 465 (1987); possible *isoleccto*: K000356597 image!).

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); T.D. Macfarlane *Fl. Australia* 45: 135 Figure 52 F–I (1987);

M. Simpson, Haemodoraceae, in K. Kubitzki, *Fam. Gen. vascular plants IV*, p. 213, Figure 54 A–B (1998); J.R. Wheeler in J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* 1: 313 (2002).

Herb annually renewed from a white ovoid corm, 13.6–39 cm tall above ground, consisting of a single stem and 1(–2) leaves, the basal leaf and sometimes a cauline leaf. *Corms* 7–10 mm diameter, covered by numerous old brown, papery sheaths, 2.7–6.0 cm below soil surface. *Roots* white, with rootlets but no visible root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 3.2–18 cm, glabrous. *Basal leaf* 6.8–21.7 cm long, erect, stem-clasping to terete, red-purple below grading to deep green, with dark mucronate tip, glabrous, some plants with a cauline leaf on the aerial stem between the basal leaf and the inflorescence bract. *Cauline leaf* similar to basal leaf only shorter. *Inflorescence bract* 2.7–14.5 cm long, erect funnel-like sheath, 4–11 mm circumference at widest point; lamina 5–80 mm long, terete, green, with a narrow membranous margin and darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to floral bract) 6.8–28 cm long, lower 1/2 becoming sparsely hairy, the remainder covered in white woolly trichomes. *Inflorescence* a compact cyme of 2–7 shortly to moderately long-pedicellate flowers, each subtended by a single floral bract. *Floral bract* 7–18 mm long, 3.5–8.5 mm wide, lanceolate, green with one to several darker longitudinal striations, membranous margin fringed with white trichomes, outside surface hairy at base, inside surface glabrous, apical part 1–6 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 5–12 mm long, 2–6 mm wide, spreading, dilated toward the apex, inner and outer surfaces creamy white hairy, with a darker mucronate tip. *Perianth tube* 3.5–9.0 mm long, outer surface covered in long silky creamy white trichomes, inner surface green, glabrous. *Stamen connective appendages* 3–6 mm long, 1.5–1.7 mm wide, creamy white, topped with 4 or 5 finger-like projections with pointed tips, exceeding anther tips. *Anthers* 2–4 mm long, yellow, with cream to pink sterile apex that projects upwards, attached centrally on stamen connective appendages. *Ovary* green, half-inferior to inferior, locules 3 with many (26) ovules per locule. *Style* short to almost absent, 0.4–2 mm long, dark greenish purple. *Stigma* capitate, green, with elongated tip topped with three glandular protuberances and covered in white trichomes. *Capsule* greyish brown; perianth persistent; lobes spreading before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 22, 23)

Diagnostic features. Tall plant, terete leaf, long peduncles, multi-flowered inflorescence, woolly creamy white flowers with perianth lobes dilated toward the apex, cream stamen connective appendages, short to almost absent style with stigma bearing an elongated tip topped with three glandular protuberances and covered in white trichomes, half-inferior to inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Brand Hwy, 2.2 km W of Eneabba, 26 Aug. 1985, *M.E. Ballingall* 1955 (PERTH); Lake Wannamal Nature Reserve, 1 km E of Bindoon–Moorra Rd, 9 Sep. 2014, *K.L. Brown & G. Paczkowska* KLB 1150 (PERTH); Surprise Forest Block, 2.8 km W of Nornalup Rd on Mountain Rd, 22 Nov. 2004, *R.J. Cranfield & B.G. Ward* WFM 298 (PERTH); Kooljerrenup Nature Reserve, 11 Sep. 2003, *P. Foreman & J. Kelly* KO 275 (PERTH); Leda Nature Reserve, 1.2 km S of Beekeepers Rd, 6 km W of Brand Hwy, 20 Aug. 2014, *E.J. Hickman* 2014 (PERTH); Marchagee Track, 2 km W of intersection with Dewars Rd, S side of road and S side of Dewars Creek, 20 Aug. 2014, *E.J. Hickman* 2017 (PERTH); Bashford Nature Reserve, SE corner of reserve, Bootoo Rd, E of Indian Ocean Dve, 28 Aug. 2014, *E.J. Hickman* 2026 (PERTH); Munbinea Rd, 10 km S of Bibby Rd, W side of road, 28 Aug. 2014, *E.J. Hickman* 2028 (PERTH); Cantabilling Rd, 3.5 km E of Munbinea Road, S side of road, 29 Aug. 2014, *E.J. Hickman* 2035 (PERTH); Ambergate Regional Park, Queen Elizabeth Ave., 150 m N of Doyle Rd, and 100 m W of road side, 19 Sep. 2014, *E.J. Hickman* 2053 (PERTH); Albany Hwy, 8.6 km S of Mt Cooke turn-off, 9 Nov. 1975, *S.D. Hopper* 842 (PERTH); Blackwood River bridge, 11 km E of Boyup Brook, 13 Nov. 1975, *S.D. Hopper* 882

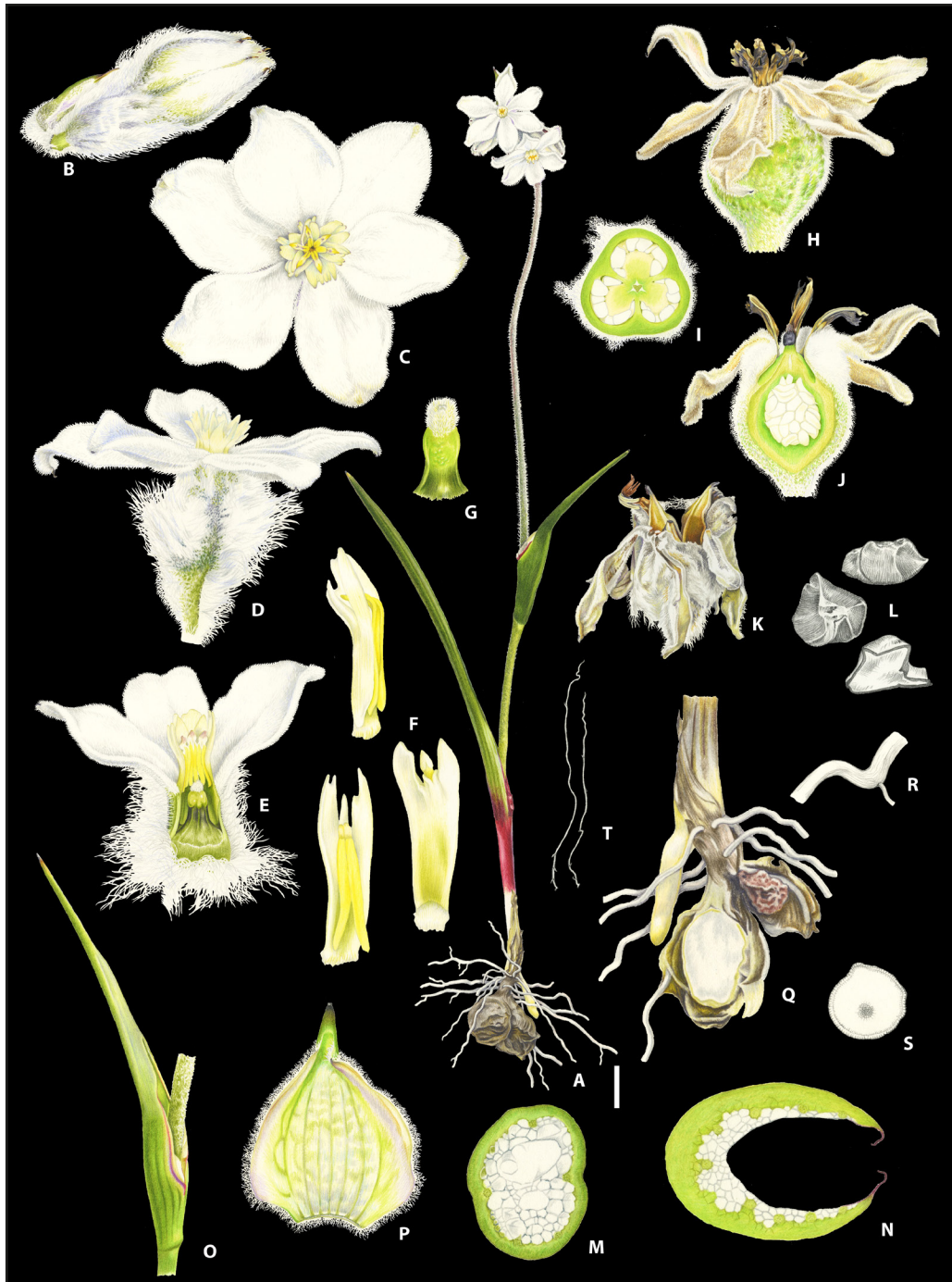


Figure 22. *Tribonanthes variabilis*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of white silky trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, H, I, J, K, P); 1 mm (F, G, M, N); 0.5 mm (L, S); 5 mm (O); 4 mm (Q); 2 mm (R); 0.65 mm (T). Drawn from fresh material E.J. Hickman 2053 (PERTH 08986975). Illustrations by E.J. Hickman.

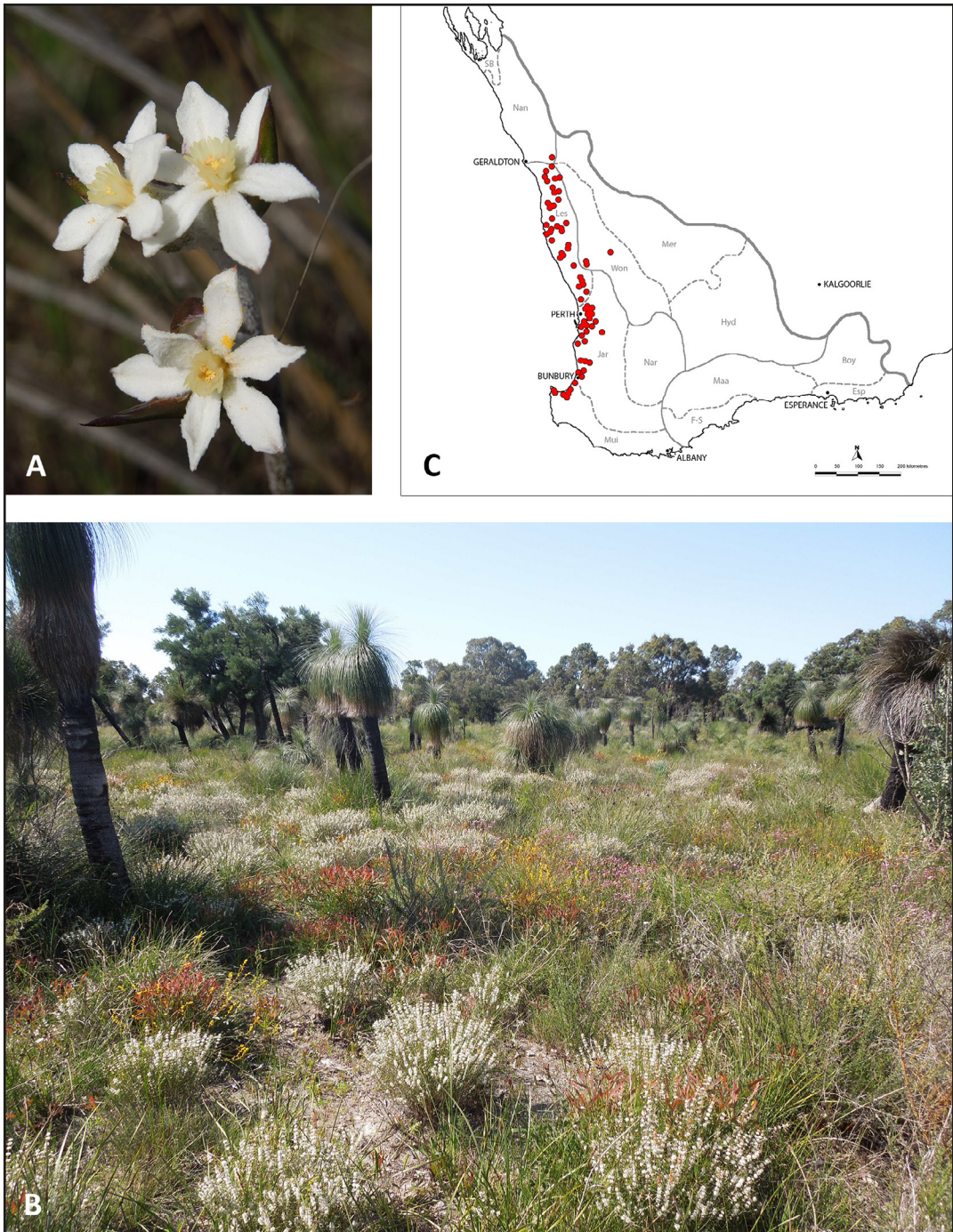


Figure 23. *Tribonanthes variabilis*. A—multi-flowered inflorescence with white woolly hairy spreading perianth lobes, and corona of cream stamen connective appendages (E.J. Hickman 2035); B – habitat (E.J. Hickman 2035), seasonally wet flat, in open *Corymbia calophylla* woodland, with dominant species *Kingia australis*, *Xanthorrhoea preissii*, *Hypocalymma angustifolium*, *Adenanthos obovatus*, *Stirlingia latifolia*, *Synaphea* sp., *Nuytsia floribunda*, Ambergate Regional Park, south of Busselton, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

(PERTH); Ring Rd, Bunbury, 19 Sep. 1983, *G.J. Keighery* 6436 (PERTH); Nullilla Nature Reserve, Gingin, 14 Sep. 2005 *G.J. Keighery* 16580 (PERTH); Harvey River District, Nov. 1901, *Miss Lambert* 814 (PERTH); Wongonderrah Rd, 9 km E of turn-off from Nambung Homestead, 30 Oct. 1999, *C. MacPherson s.n.* (PERTH); Manjimup, 28 Sep. 1948, *R.D. Royce* 2710 (PERTH); Wongan Hills, 9 Aug. 1949, *E. Salisbury s.n.* (PERTH); Augusta, 28 Aug. 2001, *J. Scott* 421 (PERTH); Brixton Street Wetlands, Kenwick, E of Brixton St and N of Wanaping Rd, 17 Aug. 2009, *K.R. Thiele* 3766 (PERTH).

Proposed vernacular name. Hairy-stigma Tiurndin.

Phenology. Flowers from August to November.

Distribution and habitat. *Tribonanthes variabilis* is found from near Geraldton along the west coast to Bunbury and inland to the Darling Scarp. Populations occur mainly within the Lesueur, Jarrah and Muir Districts of the Bibbulmun Province of the south-west of Western Australia (Gioia & Hopper 2017), but a few populations are located in the Wongan District of the Transitional Rainfall Province and the Nanda District of the Kalbarri Province. *Tribonanthes variabilis* grows on grey, brown, red-brown or black, sand, sandy clay, clay, sandy loam or peat in the winter wet flats, creek beds, along riversides and surroundings of granite outcrops, that support open woodlands, shrublands, heaths, sedgeland and herbfields. Associated species include *Corymbia calophylla*, *Eucalyptus rudis*, *E. loxophleba*, *Melaleuca raphiophylla*, *M. cuticularis*, *M. viminea*, *M. lateritia*, *M. uncinata*, *Acacia acuminata*, *A. lasiocalyx*, *Hakea ceratophylla*, *Viminaria juncea*, *Hypocalymma angustifolium* and *Xanthorrhoea preissii* (Figure 23).

Conservation status. Widespread with no special conservation needs.

Etymology. Latin for variable, originally referring to the variable nature of the stamen connective appendages within this species, of which two length conditions are mentioned in the original description of this species (Lindley 1839–40: 44), based on Georgiana Molloy collections of this species from the Vasse River (CBG 23342). As stated above, this specimen sheet actually contains two species; *T. variabilis* and *T. longipetala*, leading Lindley to describe two conditions for a single species.

Notes. Macfarlane (1987) synonymised *T. variabilis* with *T. australis*. However, *T. variabilis* and *T. australis* specimens can be distinguished by their stigmas. *Tribonanthes variabilis* has a prominent appendage covered in silky white trichomes, present on the top of the stigma, while *T. australis* only has a few scattered trichomes on the top of the stigma. In addition, the perianth of *T. variabilis* is creamy white, while *T. australis* has a purple tinge, and the perianth lobes of *T. variabilis* are dilated at the ends making their width broader relative to their length than in *T. australis*.

9. *Tribonanthes violacea* Endl. in Lehm., *Pl. Preiss.* 2: 28 (1846).

Type: Between mounts Elphinstone and Melville, Albany, Western Australia, 11 October 1840, *J.A.L. Preiss* 1562 (*holo:* LD 1811441 image!; *iso:* MEL 104289 image!, P 00753522 image!, L 1470274 image!).

Illustration. T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52 J–M (1987).

Herb annually renewed from a white ovoid corm, 4.5–12.5 cm tall above ground, consisting of a single stem and single leaf. *Corms* 6.9–9.2 mm diameter, covered by numerous old brown, papery sheaths,

1–5 cm below soil surface. *Roots* white, with a few white rootlets, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 2.5–8 cm, glabrous. *Basal leaf* 4.5–11 cm long, spreading, stem-clasping to terete, deep red-purple below grading to green with deep red margins, with mucronate tip, glabrous. *Inflorescence bract* 1.5–6.9 cm long, funnel-like sheath with broad dilated mouth, 5–11 mm circumference at widest point; lamina 5–43 mm long, terete, green with broad transparent membranous margin tinged pink, mucronate tip, glabrous. *Peduncle* (from inflorescence bract to floral bract) absent, or if present to 1.5 cm long, with a few scattered trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 5–19 mm long, 5–11 mm wide, orbicular to ovate, green with one to several darker longitudinal striations, broad membranous margin tinged pink and fringed with white trichomes, otherwise glabrous, apex 0.5–5 mm long, terete, ending in a darker tip, exceeding perianth lobes. *Perianth lobes* 4–9 mm long, 2–5 mm wide, spreading to erect, obtuse, white woolly hairy inner surface and sparsely hairy with broad central purple stripe on outer surface. *Perianth tube* 3–7.5 mm long, outer surface covered in white trichomes, inner surface white, glabrous. *Stamen connective appendages* small to residual, 1–2.5 mm long, 1.3–1.5 mm wide, white with purple tinged spot where anther attaches, with two pointed tips, shorter than anthers. *Anthers* 1.2–3.1 mm long, yellow, with pale yellow sterile apex that projects upwards, attached at top of stamen connective appendage. *Ovary* green, half-inferior, locules 3 with many (55) ovules per locule. *Style* relatively long, 1–3.2 mm, green. *Stigma* capitate, simple, yellow, with few short trichomes on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, spreading to reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 24, 25)

Diagnostic features. Medium plant, leaf lamina terete, short peduncles, solitary flowered inflorescence, woolly white flowers with more sparsely hairy purple outer surface, small to residual white stamen connective appendages, relatively long style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Mingenew, 12 July 1970, *A.M. Ashby* 3275 (PERTH); Carnaby Close, Barrens Beach Estate, Hopetoun, 22 Aug. 2004, *M. Bennett* 1121 (PERTH); Sandalwood Rd 1.5 km from Cape Riche camping area, 1 Oct. 2013, *G. Byrne* 4813 (PERTH); Wilyung Hill, Albany, 30 Aug. 2004, *R.J. Cranfield* 20469 (PERTH); Gravel pit 14 km N of Mullewa on Gascoyne Junction Rd, 14 Sep. 2005, *J. Docherty* 380 (PERTH); Cape Arid National Park, 2.5 km NW from Seal Creek Campsite on firebreak track, 27 Oct. 2013, *E.J. Hickman* 2006 (PERTH); N boundary of reserve S of Esperance Airport, 2.2 km W on Crawford Rd from Esperance–Coolgardie Rd, 28 Oct. 2013, *E.J. Hickman* 2008 (PERTH); Lort River, E bank 100 m N of bridge on South Coast Hwy, 28 Oct. 2013, *E.J. Hickman* 2009 (PERTH); Merivale, intersection of Merivale Rd and Cape le Grand Rd, on two granite hills, 1 Aug. 2016, *E.J. Hickman* 2090 (PERTH); parking bay 1.8 km N of Gibson on Coolgardie–Esperance Hwy, 6 Sep. 1982, *S.D. Hopper* 2507 (PERTH); Moore River National Park, Beermullah, 26 July 2008, *F. Hort & J. Hort* FH 3203 (PERTH); 9 km SE of Yornup, 11 Sep. 1981, *G.J. Keighery* 3995 (PERTH); 15.4 km S of Northampton along North West Coastal Hwy, 21 Aug. 1983, *C.M. Lynch* 24 (PERTH).

Proposed vernacular name. Violet Tiurndin.

Phenology. Flowers July to September.

Distribution and habitat. *Tribonanthes violacea* is known from scattered populations from Northampton, north of Geraldton, along the coast to Cape Arid National Park east of Esperance. Populations occur in the Nanda District of the Kalbarri Province, Merredin District of the Transitional Rainfall Province, Lesueur, Jarrah and Muir Districts of the Bibbulmun Province, and Fitzgerald–Stirling, Maalak, Boylya and Esperance Districts of the Southeast Coastal Province of the south-west of Western

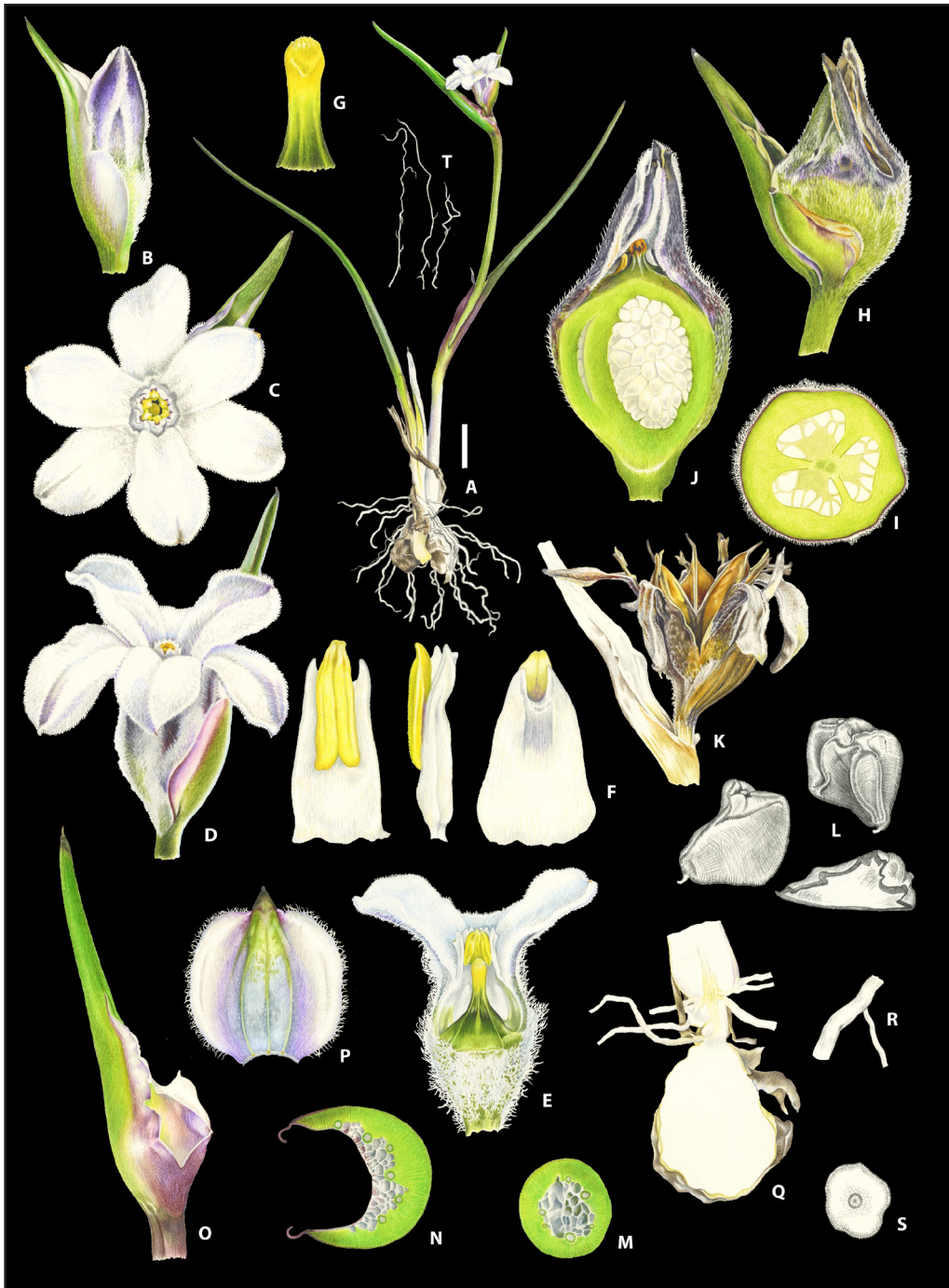


Figure 24. *Tribonanthes violacea*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing stamen connective appendages small, much shorter than anthers and yellow anthers with apex apiculate and projecting upwards; G – style elongated with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, I, J, K, O, P, Q); 1 mm (F, G, M, N, T); 4 mm (H); 0.5 mm (L, S); 2 mm (R). Drawn from fresh material E.J. Hickman 2090 (PERTH 08989524). Illustrations by E.J. Hickman.

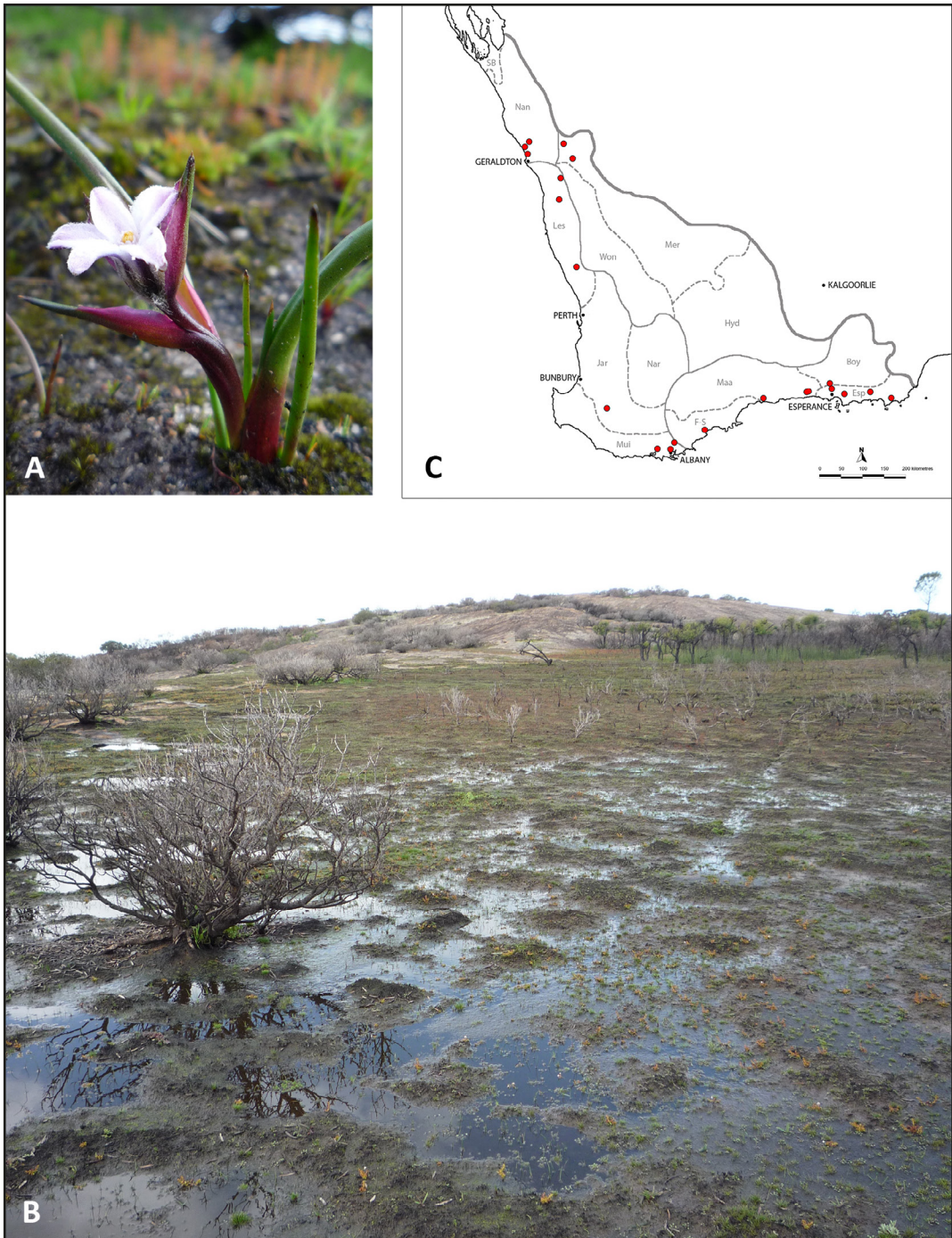


Figure 25. *Tribonanthes violacea*. A – single-flowered inflorescence with purple tinged, white woolly hairy spreading perianth lobes, on a short peduncle (E.J. Hickman 2090); B – habitat (E.J. Hickman 2090), mosaic of shrubland and moss swards on two granite hills at the intersection of Merivale Rd and Cape Le Grand Rd, Merivale, east of Esperance; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Australia (Gioia & Hopper 2017). *Tribonanthes violacea* grows on grey sand over clay associated with sandstone along creek lines and in winter wet depressions in the north and on grey sand over clay around granite outcrops or on wet winter flats in the south. These habitats support shrublands, open scrub, and heaths. Associated species include *Hakea* spp., *Melaleuca* spp., *Borya nitida*, and various herbs, sedges and grasses (Figure 25).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin for violet colour, referring to the purple tinge of the flowers of this species.

Notes. A number of species have been misidentified as *T. violacea* in the past including *T. uniflora* and the newly described *T. keigheryi*, *T. monantha* and *T. porphyrea*. *Tribonanthes violacea* is similar to *T. keigheryi* and *T. porphyrea* in having a short to indistinguishable peduncle, but differs from *T. monantha* and *T. uniflora*, which have a relatively long peduncle covered in white woolly trichomes. *Tribonanthes violacea* is similar to *T. keigheryi* in having short to residual stamen connective appendages, which are often reduced to two small points on the tip of the filament, while *T. monantha*, *T. porphyrea* and *T. uniflora* have prominent stamen connective appendages forming a distinct corona-like structure. *Tribonanthes violacea* is similar to *T. monantha*, *T. keigheryi* and *T. uniflora* in having small flowers with the perianth lobes equal or shorter than the perianth tube but differs from *T. porphyrea* which has large flowers with perianth lobes longer than the perianth tube. *Tribonanthes violacea* is similar to *T. monantha* in having inflorescence bracts with a glabrous margin, by which it differs from *T. keigheryi*, *T. porphyrea* and *T. uniflora* which have a fringe of white simple trichomes along their inflorescence bract margins. *Tribonanthes violacea* is probably most similar to *T. keigheryi* but they are distinguished by *T. violacea* being a more robust plant that dwells in damp environments associated with granite outcrops, while *T. keigheryi* is a fine slender plant that prefers swampy habitats.

10. *Tribonanthes brachypetala* Lindl., *Sketch Veg. Swan R.* xlv (1840).

Type: Swan River, Western Australia, 1839, *J. Drummond s.n.* (*holo:* CGE 06823!; *iso:* K 000846203 image!, K 000846202 image!).

Tribonanthes odora Endl., in Lehm., *Pl. Preiss.* 2: 28 (1846), *nom. illeg.*, *nom. superfl.* *Type:* Canning River, Western Australia, 1840, *J.A.L. Preiss* 2394 (*holo:* LD 1811569 image!; *iso:* MEL 104290 image!, MEL 104291 image!, MEL 104292 image!, S 06-11227 image!).

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.*, Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52 N–Q (1987); J.R. Wheeler in J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* 1: 313 (2002).

Herb annually renewed from a white ovoid corm, 21–41 cm tall above ground, consisting of a single stem and 2(–3) leaves, 1 basal and 1(–2) cauline. *Corms* 10–11 mm diameter, covered by numerous old brown, papery sheaths, 3.2–5.8 cm below soil surface. *Roots* white, with no visible root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 3.5–20 cm, mostly glabrous except upper 1/4 sparsely hairy. *Basal leaf* 3.4–22 cm long, erect, stem-clasping to terete, deep green with dark mucronate tip, glabrous. *Cauline leaf* similar to basal leaf only shorter; some plants with 1(–2) cauline leaves positioned 1/3–1/2 way up aerial stem (Figure 26A1). *Inflorescence bract* 1.8–8.2 cm long, sheath funnel-like, with broad dilated mouth 6–9 mm circumference at widest point, green with thin membranous margins, glabrous; lamina 14–55 mm long, terete, green with

darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to first floral bract) 13–26.5 mm long, covered in white woolly trichomes, with the trichomes becoming sparser in the lower 1/2. *Inflorescence* a nodding compact cyme of 3–7 sessile or shortly pedicellate flowers, each subtended by a single floral bract. *Floral bracts* 6–24 mm long, 2–10 mm wide, lanceolate, asymmetric, green with one to several darker longitudinal striations, hairy margins, hairy at base on outside surface, glabrous inside surface, apex 1–15 mm long, terete, green ending in a darker tip. *Perianth lobes* 3.5–5 mm long, 2–3 mm wide, strongly reflexed, ovate to triangular, green with white hairy outer surface, glabrous inner surface, dark red mucronate tips. *Perianth tube* length 5.2–8 mm, outer surface covered in white woolly trichomes, inner surface mostly glabrous except for scattered trichomes near the base. *Stamen connective appendages* 2.5–4 mm long, 2.2 mm wide and 1.8 mm deep, fleshy, deeply grooved on back, well exceeding anther tips, forming a conspicuous crown-like structure, yellow. *Anthers* 2–3 mm long, yellow, with cream sterile apex that projects upwards, attached on lower part of stamen connective appendages. *Ovary* green, half-inferior, locules 3 with few (6) ovules per locule. *Style* short, 0.8–2 mm long, green. *Stigma* capitate, greenish yellow, topped with three short glandular protuberances and covered with short trichomes. *Capsule* greyish brown; perianth persistent; lobes reflexed before and spreading to reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 26, 27)

Diagnostic features. Tall plant, terete leaf, long peduncles, multi-flowered nodding inflorescence, perianth lobes strongly reflexed, very obvious yellow stamen connective appendages, short style, stigma with three glandular protuberances, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Gooseberry Hill, 170 m E of Watsonia Rd and 210 m N of Gooseberry Hill Rd, 27 Aug. 2014, *E.J. Hickman* 2022 (PERTH); Watershed Rd, 4.5 km N of intersection with Basin Rd, SE side of road on wet flat, 3 Nov. 2014, *E.J. Hickman* 2074 (PERTH); Tindale Rd, Kentdale, W of Denmark, 3 Aug. 1992, *S.D. Hopper* 7286 (PERTH); 18 km S of Bridgetown, near Yornup, 8 Oct. 1982, *G.J. Keighery* 5321 (PERTH); airport, SE Bunbury, 18 Sep. 1983, *G.J. Keighery* 6426 (PERTH); Ambergate Regional Park, S of Busselton, 13 Sep. 1994, *G.J. Keighery* 13398 (PERTH); Yoongarillup Townsite Reserve, SE of Busselton, 15 Sep. 2006, *G.J. Keighery* 17030 (PERTH); Serpentine townsite, 19 Oct. 1983, *T.D. Macfarlane* 1291 (PERTH); W of Harvey, 21 Sep. 1948, *R.D. Royce* 2654 (PERTH); Unicup Rd off Muir Hwy, 19 Sep. 1987, *M. Sherwood* 869 (PERTH).

Proposed vernacular name. Nodding Tiurndin.

Phenology. Flowers from July to October.

Distribution and habitat. *Tribonanthes brachypetala* has been collected from north east of Perth on and west of the Darling Scarp, to Dunsborough, and south-east through the state forest to Mt Barker. Its most easterly population is at the base of the southern slopes of the Porongurup Range. Its distribution is concentrated along the western edge of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), mainly in the Jarrah and Muir Districts. Its easterly population is on the border of the Muir District and Fitzgerald-Stirling District of the Southeast Coastal Province. It grows on seasonally wet brown loams around granite outcrops associated with open woodlands, and on black to grey peaty or sandy clays in winter wet flats associated with open woodlands. Associated species include *Corymbia calophylla*, *Eucalyptus marginata*, *E. wandoo*, *Melaleuca raphiophylla* and *Xanthorrhoea preissii* (Figure 27).

Conservation status. Widespread with no special conservation needs.

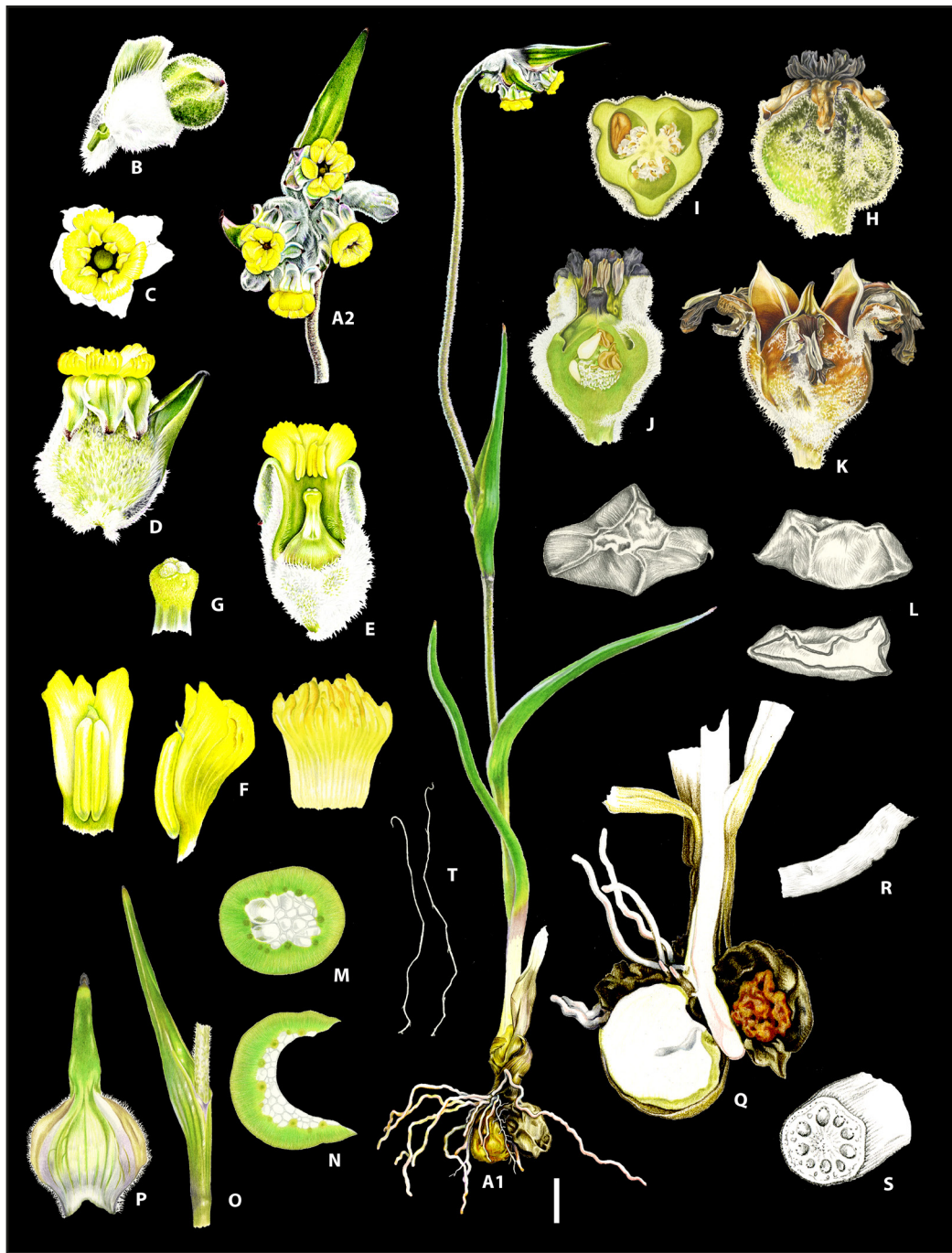


Figure 26. *Tribonanthes brachypetala*. A1 – whole plant; A2 – inflorescence; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing yellow fleshy stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting upwards; G – style short with three protuberances on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A1); 5 mm (A2); 2.5 mm (B, C, D, E, H, I, J, K, P, R); 1 mm (F, G); 0.5 mm (L, S, T); 0.65 mm (M, N); 4 mm (O, Q). A–G & M–T drawn from fresh material at Millinup Road, Porongurup Range after a fire in 2010 (no voucher) and H–L drawn from *E.J. Hickman* 2022 (PERTH 08989370). Illustrations by E.J. Hickman.

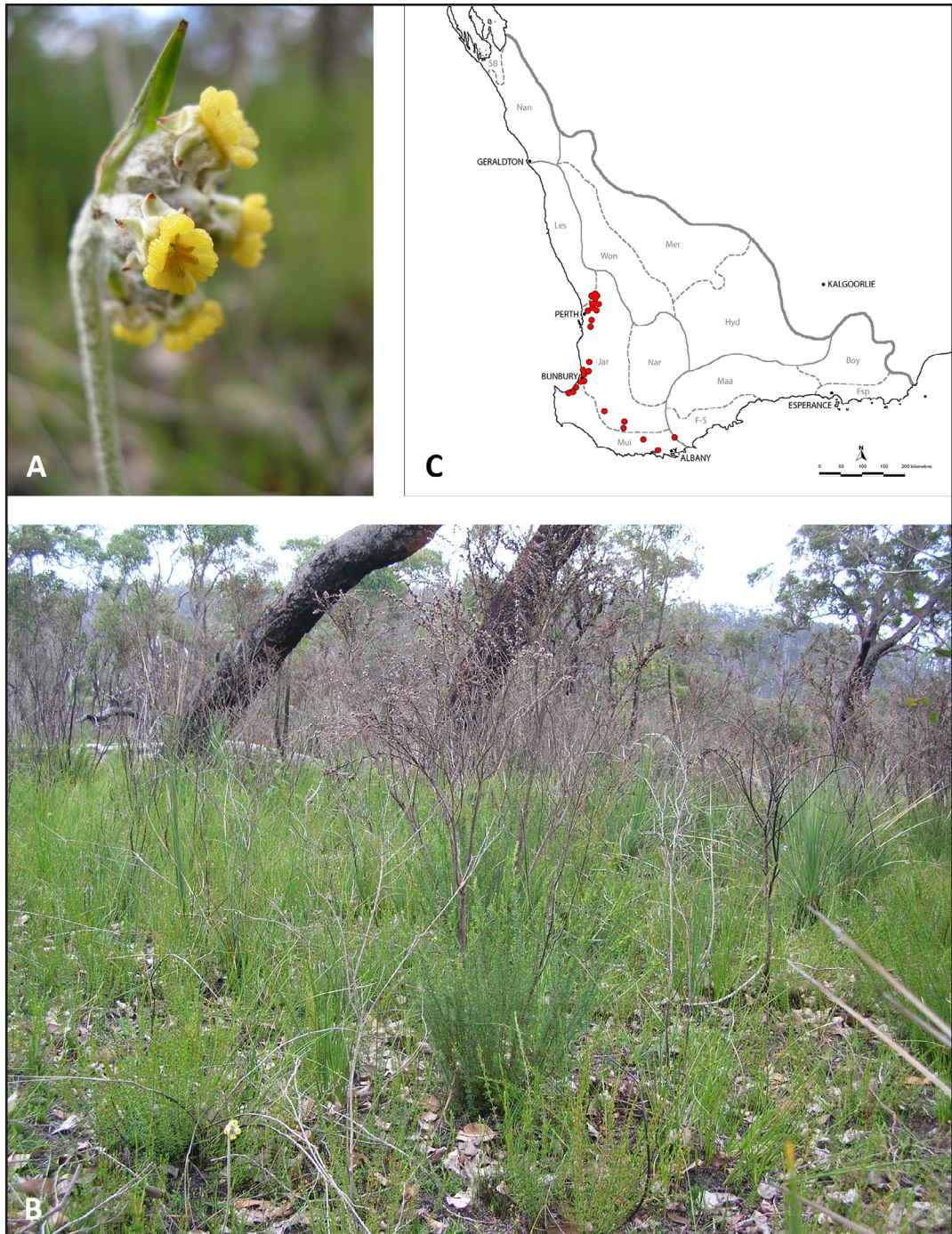


Figure 27. *Tribonanthes brachypetala*. A—plant showing multi-flowered inflorescence, with prominent yellow stamen connective appendages and reflexed perianth lobes (no voucher, Millinup Rd, Porongurup Range after a fire in 2010) B – habitat (no voucher, Millinup Rd, Porongurup Range after a fire in 2010), recently burnt open woodland of *Corymbia calophylla* and *Eucalyptus marginata* over *Taxandria parviceps*, *Astartea* sp. and *Cyathochaeta equitans* on grey brown loam over laterite at base of the southern slopes of the Porongurup Range, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Etymology. From the Greek *brachys* (short) and *petalon* (leaf, but in modern botany referring to petals).

Notes. *Tribonanthes brachypetala* is more readily observed in the flowering period following a burn of its habitat and is then found in diminishing numbers of plants in subsequent seasons for a few years after the burn. The exception is when the plants' habitat is open woodland of *Eucalyptus wandoo*, where the understorey is sparse, or on granite outcrops, when plants may flower in the absence of fire. The fruiting specimens examined show *T. brachypetala* displays early abortion of many ovules resulting in only a few seeds per capsule.

Tribonanthes Endl. subg. **Salina** E.J.Hickman & Hopper, *subg. nov.*

Type: *Tribonanthes minor* M.Lyons & Keighery

Aerial stem 1.3–4 cm tall. *Flowers* laterally horizontal, solitary. *Perianth* white to pale green with reflexed lobes. *Style* 0.5–1.5 mm long.

Etymology. From the Latin *salina* for salty, alluding to the general habitat occupied on the margins of salt lakes.

Notes. This monotypic subgenus is distinctive in its diminutive size, the smallest species known of Haemodoraceae.

11. *Tribonanthes minor* M.Lyons & Keighery, *Nuytsia* 16: 78 (2006).

Type: Chinocup Nature Reserve [precise locality withheld for conservation reasons], Western Australia, 18 October 2000, *M.N. Lyons* 2734 (*holo:* PERTH 07245890!).

Illustration. M. Lyons & G. Keighery, *Nuytsia* 16: 79, Figure 1 (2006).

Herb annually renewed from a white ovoid corm, 1.3–3.9 cm tall above ground, consisting of a single stem and single leaf. *Corms* 4–6 mm diameter, covered by numerous old brown, papery sheaths, 1.3–3.8 cm below soil surface. *Roots* white, with long fine root trichomes, some sand-binding rhizosheaths. *Aerial stem* (from basal leaf to inflorescence bract) 0.3–0.8 cm, glabrous. *Basal leaf* 1.3–3 cm long, spreading, stem-clasping to terete, deep red-purple, with a mucronate tip, glabrous. *Inflorescence bract* 0.5–0.9 cm long, funnel-like sheath with broad dilated mouth, red-purple, 2–4 mm circumference at widest point, with glabrous margin, lamina 0.2–1.5 mm long, terete, red-purple to green, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 4.5–22 mm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 4–5.5 mm long, 3–5 mm wide, ovate, pinkish-purple, broad membranous margins, with a few fringing trichomes, otherwise glabrous inside and out, apex 0.5–1 mm long terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 1.1–2 mm long, 0.8–1.2 mm wide, strongly reflexed, acute, outside surface white woolly hairy, inside surface pale green to purplish, glabrous. *Perianth tube* 2.6–3.5 mm long, outer surface covered in white woolly trichomes, inner surface pale green, glabrous. *Stamen connective appendages* relatively large, 0.7–1 mm long, 0.8–1 mm wide, fleshy, yellow, topped with 4 broad, round-tipped finger-like projections, extending above anther tips. *Anthers* 1–1.3 mm long, cream, with cream sterile apex that projects away from centre of flower, attached at base of stamen connective appendage. *Ovary* green, superior, 3 locules with several (10–12) ovules per locule. *Style* short to almost absent, 0.5–1.5 mm long, green. *Stigma* capitate, simple, yellow, covered with short

trichomes. *Capsule* greyish brown; perianth persistent; lobes reflexed before and after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 28, 29)

Diagnostic features. Small plant, terete leaf, long peduncles, solitary flowered inflorescence, strongly reflexed perianth lobes, obvious yellow stamen connective appendages, short to almost absent style with simple stigma, superior ovary.

Selected specimens examined. WESTERNAUSTRALIA [localities withheld for conservation reasons]: 4 Oct. 2007, *T. Erickson* 116 (PERTH); 28 July 2015, *E.J. Hickman* 2079 (PERTH); 28 July 2015, *E.J. Hickman* 2081 (PERTH); 12 Oct. 1988, *S.D. Hopper* 6931 (PERTH); 19 Oct. 1999, *M.N. Lyons* 2929 (PERTH); 24 Oct. 2000, *M.N. Lyons* 2735 (PERTH); 28 Aug. 2007, *R.J. Smith, S.D. Hopper & L. Sweedman* 059 (K, PERTH).

Proposed vernacular name. Salt-lake Tiurndin.

Phenology. Flowers July to August.

Distribution and habitat. *Tribonanthes minor* is known from scattered populations from the Meckering area south to the Lake King area. Populations are located in the Wongan District of the Transitional Rainfall Province and Maalak District of the Southeast Coastal Province of south-west Western Australia (Gioia & Hopper 2017). It grows on seasonally wet, low sandy rises on the margins of naturally saline lakes. The vegetation is heath, scrub and samphire flats, associated species include, *Melaleuca thyoides*, *Atriplex hymenotheca*, *Tecticornia indica*, *T. halocnemoides*, *T. leptoclada*, *Roycea spinescens*, *Samolus caespitosus*, *Tecticornia moniliformis*, *Gnephosis acicularis*, *G. tridens*, *Hyalochlamys globifera* and a variety of annual herbs (Figure 29).

Conservation status. Currently listed as Priority Three under Conservation Codes for Western Australian Flora (Smith & Jones 2018). Due to its preference for low elevations on the margins of naturally saline lakes *T. minor* is under threat from increased risk of flooding associated with changes in catchment hydrology following agricultural clearing (Lyons & Keighery 2006; Smith & Jones 2018).

Etymology. From the Latin *minor* (smaller), referring to the very small leaves, stems, flowers and perianth lobes of this species.

Notes. *Tribonanthes minor* is presently known from three or four locations, with herbarium specimens collected from all but the Lake Goorly location. Its presence at Lake Goorly was recorded in quadrats for the Salinity Action Plan survey (Keighery 2004) across the state of Western Australia in 1999 (*M. Lyons pers. comm.*, 13 September 2013), but is thought to be dubious. Field visits to Lake Goorly by N. Gibson in October 2013 (*N. Gibson pers. comm.* 22 October 2013), E.J.H. in July 2015 and S.D.H. in September 2017 failed to locate any specimens. Lake Goorly is not shown on the map (Figure 29C).

Tribonanthes Endl. subg. ***Boya*** E.J.Hickman & Hopper, *subg. nov.*

Type: *Tribonanthes purpurea* T.Macfarlane & Hopper.

Aerial stem 1.1–4.3 cm tall. *Flowers* erect, solitary. *Perianth* pink with erect lobes. *Style* 4.0–7.0 mm long.

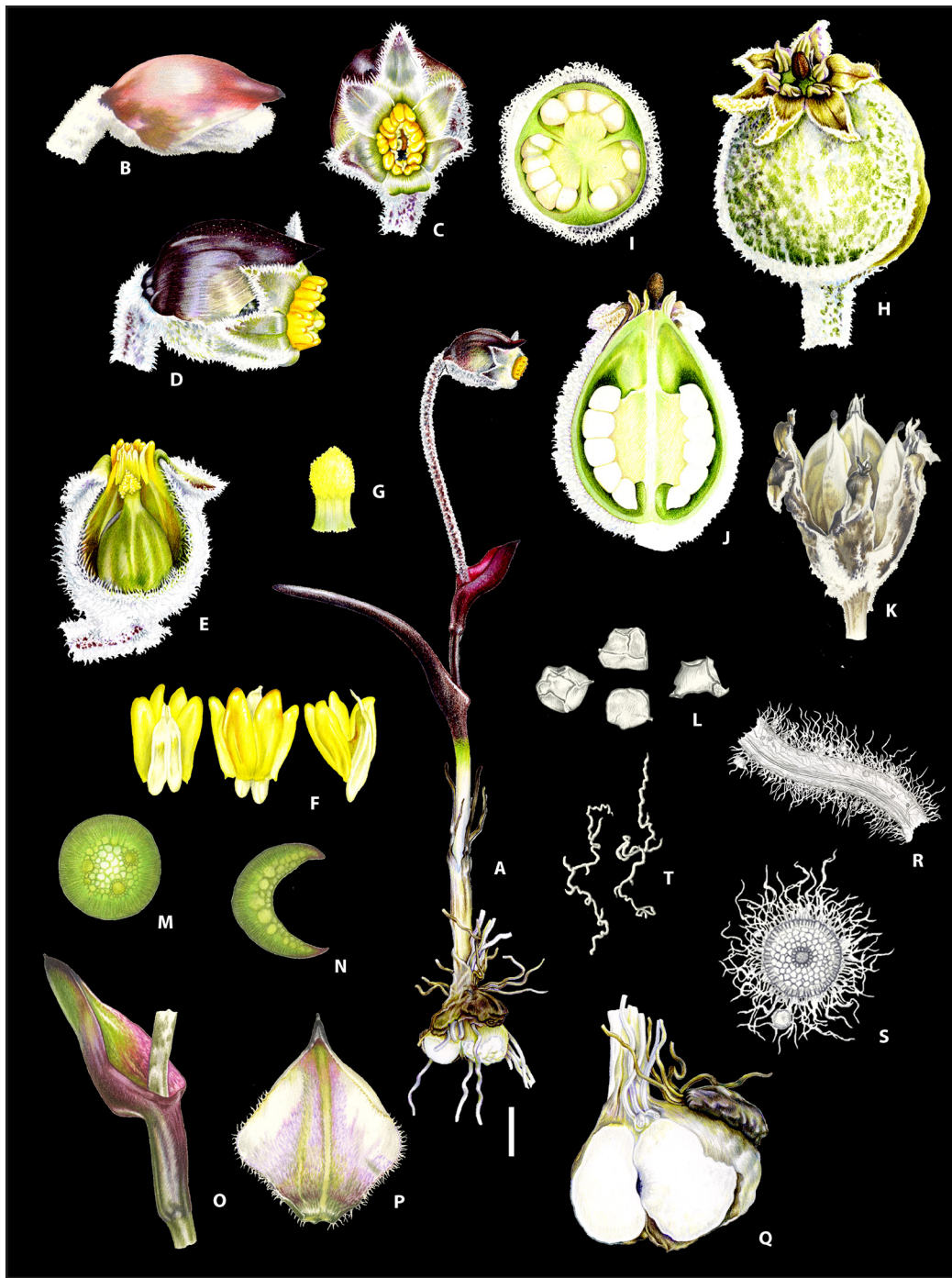


Figure 28. *Tribonanthes minor*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, back and side view showing yellow fleshy, stamen connective appendages exceeding anthers and cream anthers with apex apiculate and projecting upwards; G – style sub-sessile with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 2.5 mm (A); 1 mm (B, C, D, E, H, I, J, K, O, P); 0.5 mm (F, G, M, N, R, T); 0.4 mm (L); 2 mm (Q); 0.2 mm (S). Drawn from fresh material E.J. Hickman 2079 (PERTH 08989427). Illustrations by E.J. Hickman.

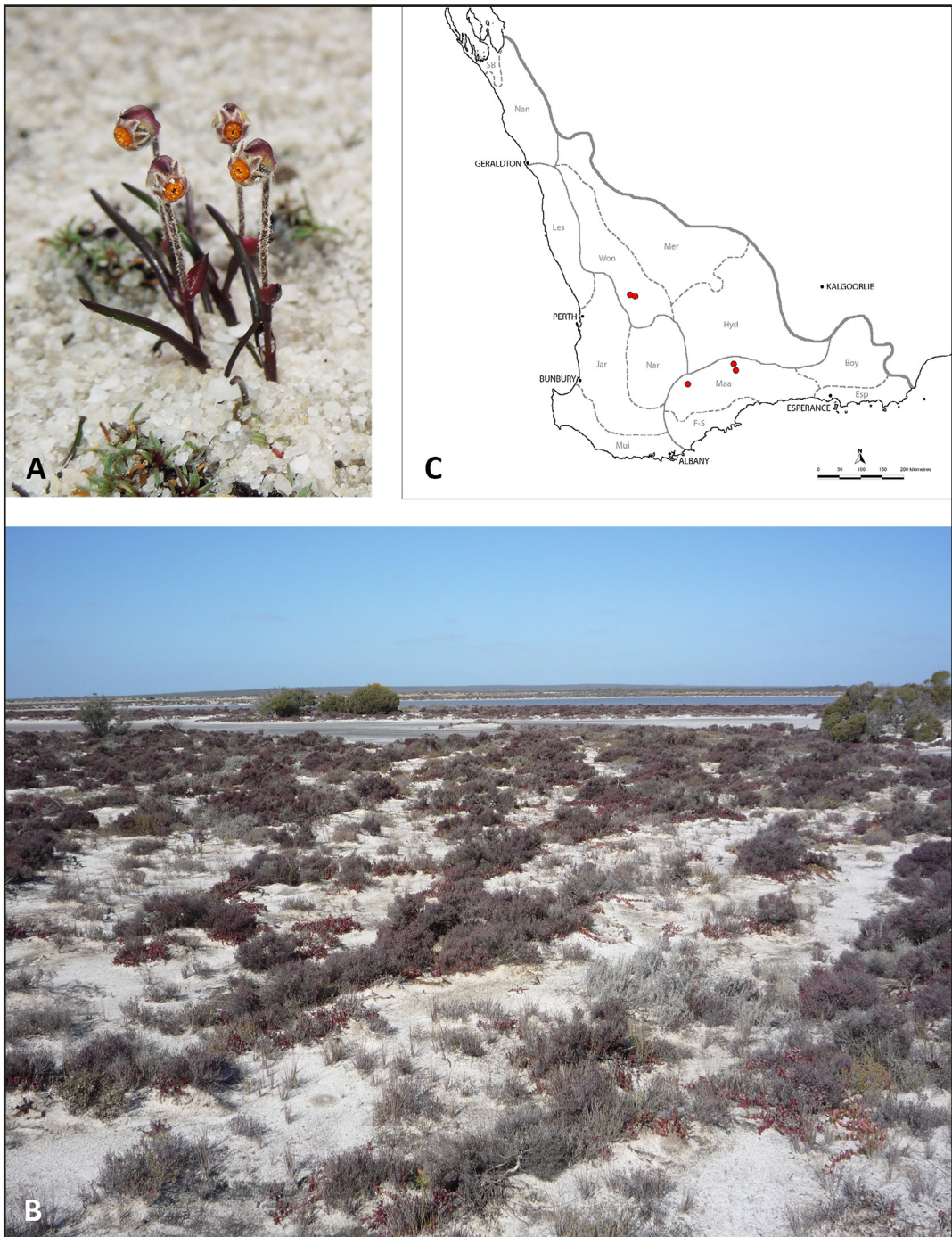


Figure 29. *Tribonanthes minor*. A – group of plants each with a single-flowered inflorescence with obvious yellow stamen connective appendages and strongly reflexed perianth lobes (E.J. Hickman 2079); B – habitat of *T. minor* (E.J. Hickman 2081), samphire on low sandy rises; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Etymology. From the Noongar word *boya* for granite rock or stone, as a noun in apposition, alluding to the habitat occupied by the sole species.

Notes. A monotypic subgenus distinctive in its almost stemless pink erect tubular flowers.

12. *Tribonanthes purpurea* T.Macfarlane & Hopper, *Fl. Australia* 45: 465 (1987).

Type: near Kuender [precise locality withheld for conservation reasons], Western Australia, 27 August 1986, S.D. Hopper 5237 (*holo:* PERTH 01008625!; *iso:* CANB. 00394484 image!).

Illustrations. T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52 R-U (1987); S.D. Hopper, S. van Leeuwen, A.P. Brown & S.J. Patrick, *WA Endemic Flora* p. 79 (1990); A. Brown, C. Thomson-Dans & N. Marchant, *WA Threatened Flora* p. 167 (1998).

Herb annually renewed from a white ovoid corm, 1.1–4.3 cm tall, consisting of a single stem and single leaf. *Corms* 5–6 mm diameter, covered by numerous old brown, papery sheaths, 1–4.6 cm below surface. *Roots* white, with long fine root trichomes, lacking a sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 0.1–2.2 cm, glabrous. *Basal leaf* 2–5.4 cm long, spreading, stem-clasping base, becoming terete, the base white grading to green, with darker mucronate tip, glabrous. *Inflorescence bract* 9–20 mm long, erect, funnel-like sheath with broad dilated mouth, 6–12 mm circumference at widest point, purplish green with broad pinkish purple membranous margins, glabrous; lamina 2–10 mm long, terete, green with a mucronate tip. *Peduncle* (from inflorescence bract to floral bract) absent, or if present to 0.2 cm long, glabrous. *Inflorescence* a solitary flower, often appearing geoflorous, subtended by the inflorescence bract and a floral bract. *Floral bract* 6–13 mm long, 4–10 mm wide, ovate, green with broad pinkish purple membranous margins, inside and outside surfaces glabrous, apex 1–4 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 4–6.1 mm long, 1.6–3 mm wide, erect, oblong, pink, glabrous inside and outside, outer lobes with reddish-purple gland-like protuberances at apex. *Perianth tube* 4.6–7 mm long, white, glabrous inside and outside. *Stamen connective appendages* scarcely developed, 2–3 white projections, much shorter than anther tips. *Anthers* 1–2 mm long, yellow, with cream sterile apex that projects upwards, attached towards top of stamen connective appendage. *Ovary* green, superior, 3 locules with few (7) ovules per locule. *Style* long, 4.0–7.0 mm, green. *Stigma* capitate, simple, yellow, with a few short trichomes on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, upwardly spreading after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 30, 31)

Diagnostic features. Small plant, terete leaf, peduncles absent or rudimentary, solitary flowered inflorescence, pink glabrous flowers often appearing geoflorous, stamen connective appendages scarcely developed, superior ovary, long style with simple stigma.

Selected specimens examined. WESTERNAUSTRALIA [localities withheld for conservation reasons]: 29 Aug. 1994, A.M. Coates 4312 (PERTH); 31 July 1999, V. Crowley s.n. (PERTH); 12 Sep. 1995, R. Cugley 7 (PERTH); 23 Aug. 2004, R. Cugley 159 (PERTH); 22 Aug. 1990, D. Davidson s.n. (PERTH); 28 July 2015, E.J. Hickman 2080 (PERTH); 29 July 2015, E.J. Hickman 2082 (PERTH); 1 Aug. 2015, E.J. Hickman 2083 (PERTH); 1 Aug. 2004, G.J. & B.J. Keighery 270 (PERTH); 2 Sep. 2011, D. Sandow et al. DSA 07 (PERTH).

Proposed vernacular name. Granite Pink (proposed by Hopper et al. 1990).

Phenology. Flowers from July to September.

Distribution and habitat. *Tribonanthes purpurea* is known from the Mt Dale area in the Darling Range to the Porongurup Range and east to Varley. Populations are located within the Jarrah and Narrogin Districts of the Bibbulmun Province, the Hyden District of the Transitional Rainfall Province and the Maalak and Fitzgerald-Stirling Districts of the Southeast Coastal Province of south-west Western Australia (Gioia & Hopper 2017). *Tribonanthes purpurea* mostly grows on brown sandy loam associated with granite outcrops but has also been found growing on grey sandy clays of winter wet flats. These habitats support moss swards, herbfields, heath and shrublands with associated species including *Thryptomene australis*, *Borya constricta*, *Dodonaea viscosa*, *Melaleuca elliptica*, *M. viminea*, *M. uncinata*, *Acacia lasiocalyx*, *Spartochloa scirpoidea*, *Stypandra glauca*, *Drosera* spp., *Stylidium* spp., *Caladenia* spp. and *Wurmbea* spp. (Figure 31).

Conservation status. Threatened Flora protected under the *Biodiversity Conservation Act 2016* with a ranking of Vulnerable. Due to its small stature, succulent leaves and occurrence on open herbfields, it is under threat from grazing by rabbits (Brown *et al.* 1998; Smith & Jones 2018). Its ability to regenerate after grazing is unknown.

Etymology. Specific name from the Latin *purpureus* meaning purple, or red with a touch of blue, referring to the pink perianth lobes of this species.

Notes. *Tribonanthes purpurea* is the most distinctive species of the genus with its glabrous pink flowers. Presently it is known from 14 populations, several of which have sub-populations within the same granite outcrop complex. However, the senior author has revisited several of these populations over the last five years and not relocated the plants at three locations – Beaufort River, Porongurup Range and north of the Stirling Range. Neither author has visited the Hillman location.

Natural hybrids

A small number of natural hybrid combinations of *Tribonanthes* have been recorded in herbarium collections at PERTH. Apart from morphological intermediacy and comparative rarity in populations of abundant likely parents, evidence in favour of the occurrence of natural hybridization is cited on the label of one specimen where pollen fertility was reduced to 62% in the putative hybrid of *T. australis* × ? *violacea* (S.D. Hopper 5776).

***Tribonanthes australis* Endl. × *brachypetala* Lindl.**

Specimens examined. WESTERNAUSTRALIA: Brixton Road, Beckenham, 13 Aug. 1983, *G.J. Keighery* 6249 (PERTH); airport, 6 km SE Bunbury to Boyanup, 19 Sep. 1983, *G.J. Keighery* 6427 (PERTH); 9 km along Railway Rd, Boyanup to Capel, 29 Aug. 1984, *G.J. Keighery* 6828 (PERTH); Ambergate Regional Park, S of Busselton, 13 Sep. 1994, *G.J. Keighery* 13399 (PERTH); Yoongarillup Townsite Reserve, SE of Busselton, 15 Sep. 2006, *G.J. Keighery* 17029 (PERTH).

***Tribonanthes australis* Endl. × *longipetala* Lindl.**

Specimens examined. WESTERN AUSTRALIA: Brixton Rd, Beckenham, Perth, 21 Aug. 1983, *G.J. Keighery* 6260 (PERTH); Pinjarra Nature Reserve, Pinjarra, 30 Aug. 2007, *G.J. Keighery* 17133 (PERTH).



Figure 30. *Tribonanthes purpurea*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and elongated style; F – stamens from front, side and back view showing stamen connective appendages scarcely developed, translucent, surface punctate, much shorter than anthers and yellow anthers with apex apiculate and projecting upwards; G – style tip with capitate stigma; H – capsule, glabrous; I – cross section of capsule; J – longitudinal section of capsule; K – dehiscent capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth tip. Scale bars = 4 mm (A); 1.5 mm (B, C, D, E, H, I, J, K); 0.5 mm (F, G, L, M, N); 2 mm (O, P, Q); 1 mm (R); 0.4 mm (S, T). Drawn from fresh material E.J. Hickman 2083 (PERTH 08989443). Illustrations by E.J. Hickman.

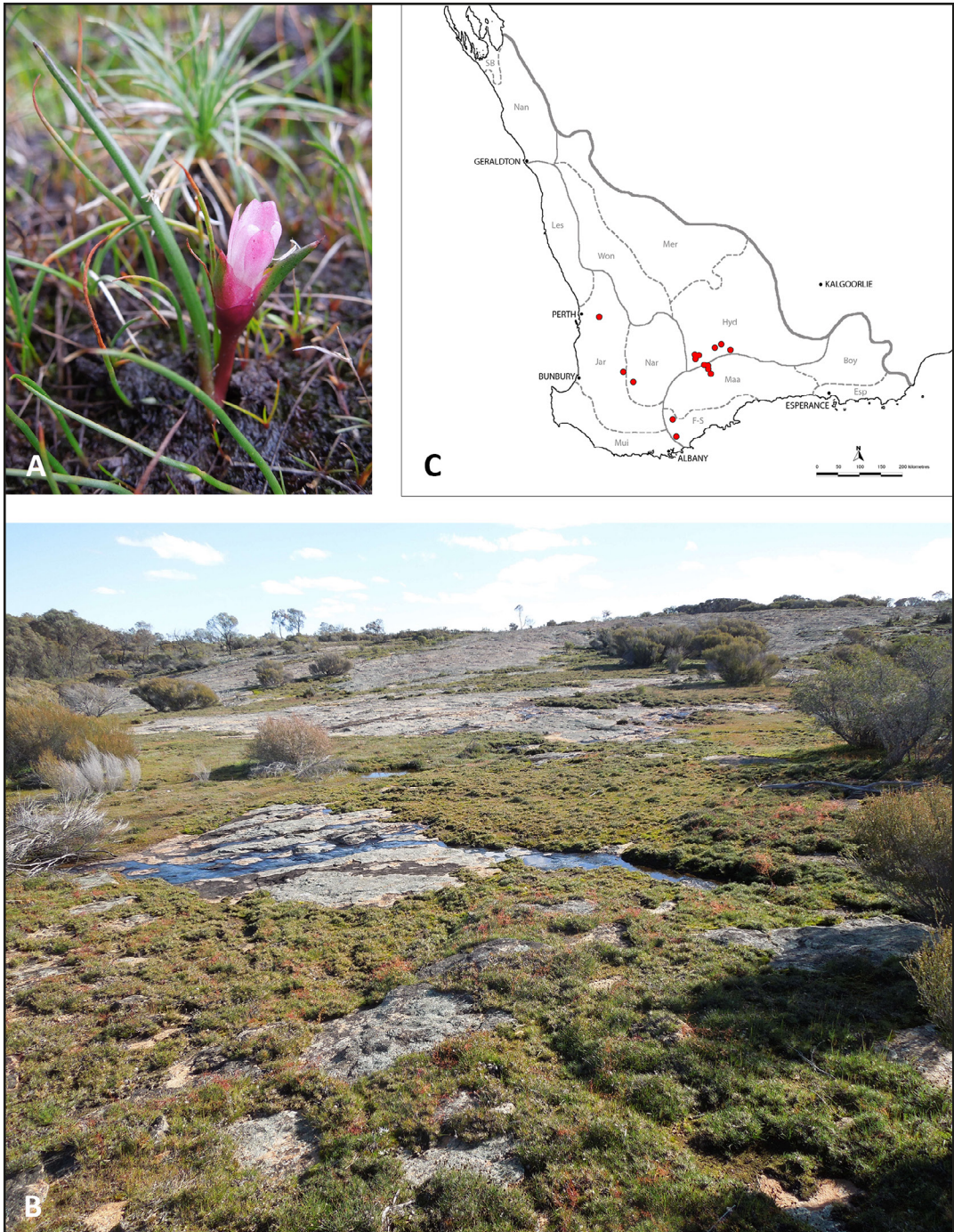


Figure 31. *Tribonanthes purpurea*. A – single-flowered inflorescence with pink, glabrous, erect perianth lobes, (E.J. Hickman 2080); B – habitat of *T. purpurea* (E.J. Hickman 2080), *Borya* herbfield and moss swards in shallow soil pockets between granite sheets; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Tribonanthes australis Endl. × ?**violacea** Endl.

Specimen examined. WESTERN AUSTRALIA: 12.6 km off Unicup Rd along Wingebellup Rd, ESE to Unicup Lake, 16 Oct. 1986, S.D. Hopper 5776 (PERTH).

Tribonanthes variabilis Lindl. × **brachypetala** Lindl.

Specimen examined. WESTERN AUSTRALIA: Brixton Street Wetlands, Kenwick, 24 Aug. 2010, K.L. Brown & G. Paczkowska KLB 854 (PERTH).

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