

## Taxonomic revision of *Corynotheca* (Hemerocallidaceae / Asphodelaceae)

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### Abstract

The genus *Corynotheca* F.Muell. ex Benth. is revised and *Corynotheca borealis* R.L.Barrett, Keighery & T.Macfarlane is described as a new species from the east Kimberley region of Western Australia and the adjacent Northern Territory. *Corynotheca dichotoma* (F.Muell.) F.Muell. ex Benth. is reinstated for a species growing on yellow sands in the Mid West of Western Australia. The taxonomic and geographic limits of varieties of *C. micrantha* (Lindl.) Druce are reconsidered and all are recognised at specific rank. Four new combinations are made: *Corynotheca divaricata* (R.J.F.Hend.) R.L.Barrett & T.Macfarlane, *Corynotheca elongata* (R.J.F.Hend.) R.L.Barrett & T.Macfarlane, *Corynotheca gracilis* (R.J.F.Hend.) R.L.Barrett & T.Macfarlane and *Corynotheca panda* (R.J.F.Hend.) R.L.Barrett & T.Macfarlane. All are illustrated and a revised key to the thirteen species of *Corynotheca* recognised is provided.

### Introduction

Classification of the lilioid monocots has undergone significant revision in recent decades (see Chase *et al.* 1996; Rudall *et al.* 2000; Rudall and Chase 1996 for reviews). A robust delimitation of Asparagales based on molecular phylogenetic data was presented by Fay *et al.* (2000), and subsequent refinements have generally focussed on the placement of particular genera, and the recognition of definable families. Hemerocallidaceae has been promoted as a useful family in many publications, though with varying circumscription (e.g. Clifford *et al.* 1998), and is still recognised by some (e.g. Boatwright and Manning 2010; Kaigongi 2020). Clifford and Conran (1998) included *Corynotheca* F.Muell. ex Benth. in Johnsoniaceae, a clade now accepted as belonging within the Hemerocallidoideae, and there is a growing acceptance of a broadly defined Asphodelaceae (formerly Xanthorrhoeaceae; sensu APG IV, 2016, see Klopper *et al.* 2013), including subfamily Hemerocallidoideae (Chase *et al.* 2000, 2009; Givnish *et al.* 2018).

*Corynotheca* is here recognised as a genus of thirteen species, all endemic in Australia. Phylogenetic data place *Corynotheca* as sister to a clade including *Arnocrinum* Endl. & Lehm, *Caesia* R.Br., *Johnsonia* R.Br.,

*Hodgsoniola* F.Muell. and *Hensmania* W.Fitzg. (the Johnsonioid clade), and related to *Tricoryne* R.Br., genera with a number of general similarities in floral morphology and most genera having arillate seeds (Clifford and Conran 1998; McPherson *et al.*, 2004; Devey *et al.* 2006; Wurdack and Dorr 2009; Seberg and Peterson 2012; Steele *et al.* 2012; Chen *et al.* 2013; McLay and Bayly 2016; Givnish *et al.* 2018). The Johnsonioid clade is endemic to Australia, except for a few species of *Caesia* in southern Africa (Boatwright and Manning 2010). Detailed phylogenetic studies based on nuclear and chloroplast markers and complete plastome data are underway that also support a relationship between *Corynotheca* and the Johnsonioid clade (A. Webb, J. Birch and B. Gunn, pers. comm.).

*Corynotheca* is unique in the Johnsonioid clade in the following characters: leaves are caducous (quickly withering); the inflorescences are large and persistent, giving a shrub-like appearance, and commonly divaricate; anthers dehisce introrsely (Clifford and Conran 1998). The aril on the seed is unusual, with only four ‘shrubby’ *Caesia* species (*C. arcuata* T.Macfarlane, Conran & C.J.French, *C. rigidifolia* F.Muell., *C. viscosa* Keighery and *C. sp.* Great Victoria Desert (*C. Tauss* 2835)) having similar arils (Macfarlane *et al.* 2020a). A closer relationship with *Arnocrinum* is possible, the two genera sharing 6 stamens with alternately long and short staminal filaments, though in *Arnocrinum* the tepals are purple, fused to a greater degree ( $\pm$ half their length), the anthers are connate, forming a tube around the style and the reticulately ornamented seeds lack an aril (Keighery 1987a; Clifford and Conran 1998). Chromosome numbers appear to be indicative of relationships as *Corynotheca*, *Caesia* and *Tricoryne* all appear to have an ancestral basic chromosome number of  $n = 7$ , while *Arnocrinum* is based on  $n = 6$  (Keighery 1984; Clifford and Conran 1998), so *Corynotheca*, with  $2n = 42$ , appears to have undergone a chromosome duplication event. *Arnocrinum* has retained a base chromosome number of  $2n = 24$  while two *Caesia* species have  $2n = 28$  and  $56$  respectively, suggesting a chromosome duplication event within *Caesia*. To date, relatively few species have been studied, and additional counts may prove informative.

*Corynotheca*, *Caesia* and *Tricoryne* all occur in temperate, tropical and arid Australia, though individual species are almost universally restricted to a single biome. *Corynotheca* has a rhizomatous habit, with often shrub-like perennial stems that are usually more or less leafless and both capsular and nut like fruits *Caesia* is perhaps the most ‘lily’-like genus, with an annually replaced basal rosette of leaves and tuberous roots in most species, and most are drought avoiders, dying back to the underground root tubers. Four ‘shrubby’ *Caesia* species (noted above) have tough leaves that dry up, leaving the green stem to perennate; roots that may be more or less uniformly thickened or narrowly dauciform; and have *Corynotheca*-like arillate seeds. They use the stored food in their root tubers to resprout after fire. These are also annually replaced, and store starch (Pate and Dixon 1983). Tuber morphology (distally or evenly swollen roots) appears to define two major groups within *Caesia*. *Tricoryne* contains a group of leafy species with tuberous roots that store starch, but these may not die back in summer, although the green stems may replace the leaves as the photosynthetic unit as many species are summer flowering.

Members of the genera *Corynotheca* and *Tricoryne* have parallel adaptations as a group of leafless rhizomatous species where the perennial stems have replaced the leaves as the photosynthetic unit. Members resprout from buds on the rhizome after fires. They also produce numerous long slender roots, which may aid nutrient acquisition, rather than the short thick or tuberous roots produced in *Caesia*. Although both genera have colonized and speciated on the sandy inland soils, *Corynotheca* species are more widespread in the arid zone of inland Australia. *Caesia* species and the tuberous *Tricoryne* species have primarily colonised rocky habitats. Most of these species in *Tricoryne* are currently unnamed and are represented in *FloraBase* by phrase names (Western Australian Herbarium 1998–).

In *Corynotheca*, *Caesia* and *Tricoryne*, flowers are diurnal, lasting a single day and the perianth twists after flowering. All members observed are pollinated mainly by small, solitary bees (Figure 11 D–F), although wasps and flies (Figure 16 F) also visit the flowers, but appear to be less efficient pollinators (G.J.Keighery, pers. obs.). All members tend to occur in dense populations and open only a limited number of flowers per plant at a time. While most species of all genera observed in cultivation or in bushland can self-pollinate on flower closure, capsule set following selfing is uniformly low, to almost zero, compared to very high set following cross-pollination (G.J.Keighery, pers. obs.).

*Corynotheca* flowers are white and bowl shaped, with readily available nectar, but little is known of their pollination biology. Most members of *Caesia* have white or blue, open bowl shaped flowers with readily available nectar. These are visited by bees from the genera *Lasioglossum* Curtis, *Leioproctus* Smith and *Nomia* Latreille. *Caesia* sp. Wongan (K.F. Kenneally 8820) has become effectively buzz pollinated by *Leioproctus* bees, having reflexed, blue perianth lobes, yellow anthers clustered around the style and no apparent nectar. *Tricoryne* is the exception in this group of genera, with large yellow flowers having hairy anther filaments. While a small amount of nectar is produced, most bees concentrate on pollen collecting, with the nectar at the

base of the flowers usually ignored, perhaps obscured by the dense anther filament hairs. Although *Tricoryne* is visited by bees for pollen, the anthers are not buzzed as claimed in some texts, the anthers dehiscing by longitudinal slits (G.J. Keighery, pers. obs.).

Members of the genus *Caesia* have capsular fruits which dehisce to release shiny or dull black seeds with a papery, cap-like aril that are ant dispersed in the few species observed (*C. micrantha*, *C. occidentalis* and *C. setifera*; G.J.Keighery, pers. obs.). Ant dispersal is a common feature of many Australian Asparagales. Some *Corynotheca* species retain a capsular (though eventually dehiscent) fruit that releases black seeds with a firm, white aril, but many can appear to have a nut-like fruit. These fall from the plants when mature, but there is no data on dispersal. The fruit of *Tricoryne* are schizocarpic, developing from the deeply divided ovary, and the seeds lack an aril, so they are quite distinct from single-seeded *Corynotheca* fruit.

Taxa now placed in *Corynotheca* were described by Brown (1810), Mueller (1859), Bentham (1878), Gauba (1948), and Henderson (1987). Nomenclatural changes within *Corynotheca* have been made by Endlicher (1846), Baker (1876), Bentham (1878), Druce (1917), Macbride (1918) and Henderson (1987). The taxonomic treatment by Henderson (1987) presented a major advance in our understanding of the genus *Corynotheca*, describing seven new taxa that are all recognised in this revision. Henderson (1987) often had only limited material available, noting that further study was warranted, and indicated that his new varieties might in future merit the rank of species, a finding we confirm here based on the examination of additional collections.

Many of Henderson's measurements and observations for particular taxa have been expanded based on more recent collections, but his taxonomic concepts have been little-modified by us in this paper, except for the recognition of two additional species and recognition of his varieties at specific rank. Henderson's original key did not account for the full range of variation found in *Corynotheca*, leading to numerous misidentifications, so a new key is provided below, with a similar framework. In addition to these taxonomic accounts, partial or regional accounts of *Corynotheca* have been provided by Mueller (1870), Bailey (1913), Black (1922, 1943), Eichler (1965), Cunningham *et al.* (1981), Jessop (1981, 1986), Macfarlane (1987), Bennett and Dundas (1988), Clifford *et al.* (1992), Rye (1992), McCune and Hardin (1993), Conran and Walsh (1994), Kenneally *et al.* (1996), Wheeler and Graham (2002), Barrett and Pin Tay (2016), Keeble (2017) and Eichler (2018).

Key features for identification of *Corynotheca* species include roots, rhizomes, stem branching patterns, leaves, inflorescence structure, tepal shape and size, anther filament colour and seed morphology, as described in the methods section below. The plasticity of many of these morphological characters (often in response to environmental conditions) makes speculation on relationships between most species based on morphology alone a tenuous exercise. It is possible that white *vs* yellow anther filaments divides the genus into two natural groups. All tropical species except *C. flexuosissima* have yellow anther filaments, while *C. divaricata*, *C. licrota* and *C. pungens* are the only species with yellow anther filaments that extend south of the tropic, all growing in relatively arid areas. The dense, perennial, shrub-like habit and ability to resprout rapidly after fire probably make *Corynotheca* species important habitat plants for invertebrates and small vertebrates.

The new species described in this revision builds on regional studies of Asparagoid monocot taxonomy in Western Australia (Macfarlane and Conran 2015; Macfarlane and Keighery 2015; Barrett 2018). This small genus exhibits interesting patterns of biogeography, and development of a comprehensive molecular phylogeny would be a rewarding exercise to determine the relationships and patterns of speciation within the genus. Like numerous Australian monocot genera (e.g. *Calectasia* R.Br., Barrett and Dixon 2001; Barrett and Barrett 2015; *Chaetospora* R.Br., Barrett *et al.* 2020; *Laxmannia* R.Br., Keighery 1987b; *Lepidosperma* Labill., Barrett and Wilson 2012; *Thysanotus* R.Br., Sirisena *et al.* 2016; Macfarlane *et al.* 2020b), the highest diversity of species is found in the south-west of Western Australia, inviting further research on the origins and diversification of these genera.

## Methods

The descriptions are based primarily on dried herbarium material held at AD, BRI, CANB, MEL, NSW and PERTH. Historical specimens have been critical to understanding species concepts, and the determination of conservation priorities as there have been documented range reductions in species such as *C. acanthoclada* and the value of herbarium collections in this regard must be emphasised (Thomson *et al.* 2018; Raven and Miller 2020). All specimens have been seen unless otherwise noted. Where only images have been examined (either on <https://plants.jstor.org> or digital photographs supplied by individuals), these are indicated by '\*'. Colour and shape of flowers is based on photographs and field observations, including collectors' notes.

Roots and rhizomes (true stems) are rarely collected but are useful to distinguish some species. Branching patterns differ between sections of growth. True stems are subterranean, lateral and short. Most, if not

all, species can re-sprout following fire. New growth following fire can be more elongate and less angular than regular growth, sometimes making identification more difficult if only regrowth material is collected. Following Clifford and Conran (1998), tall above-ground growth is interpreted as the inflorescence, so all the reduced foliage is interpreted as bracts, even though leaf-like in *C. pungens*. True leaves are poorly known as most species have only a few leaves arising from the subterranean stem that usually senesce prior to anthesis, so they are missing from most collections.

Primary inflorescence branches (including the peduncle) are usually erect, sometimes decumbent, and unbranched. Secondary stems are usually multi-branched and vary greatly between species in angle of divergence at nodes. Flowers develop on tertiary stems termed racemules, which also vary greatly between species in angle of divergence at nodes. A racemule is here interpreted as a single (ultimate) inflorescence branch produced on secondary stems. Angles of divergence at the nodes are measured as ‘outside’ angles from the continuing axis, so non-divergent stems continue at 180°, rather than being recorded as 0° divergence from the continuing axis. The determination of branching versus the continuing axis is based on the position of the bract. Sometimes the branch is at such an angle and thickness that it looks like it should be the axis, but the bract shows otherwise, the new branch developing between the bract and the continuing axis (Figure 1). The inflorescences structure, and the manner in which angles have been measured, are illustrated in Figure 1. Inflorescence branching patterns of representative species are shown in Figures 2–5.

The proportion of flowers developing per racemule is variable, even if the number of nodes is regular. While there are trends in particular species, leading Henderson (1987) to use this as a potential taxonomic character, this probably reflects environmental conditions during anthesis, with species from more arid areas commonly aborting most flowers but still developing most under ideal conditions.

As Henderson (1987) noted, fruit shape varies considerably depending on the number of seeds that develop. A maximum of three seeds have been observed in a single capsule, though development of up to six may be possible under ideal conditions. Most seeds are smooth and glossy until just before full maturity, when they become longitudinally striate, so observations of seed morphology need to carefully assess seed maturity. It appears that when multiple seeds develop in a single capsule, one seed may remain smooth, perhaps due to ‘stunted’ development. *Corynotheca divaricata* is the exception in the genus, with all seeds remaining smooth, or becoming very finely pitted. *Corynotheca licrota* may produce both smooth and striate seeds in a single capsule, but this might reflect the stage of development of individual seeds at the time of collection. While Henderson (1987) excluded the caruncle from seed length measurements, the caruncle is included here in the seed length measurement as sufficient mature seeds are now available for most taxa to obtain a reliable range of variation.

*Corynotheca asperata* R.J.F.Hend. is still poorly collected due to its remote distribution and some plant base, fruit and seed characters remain unknown.

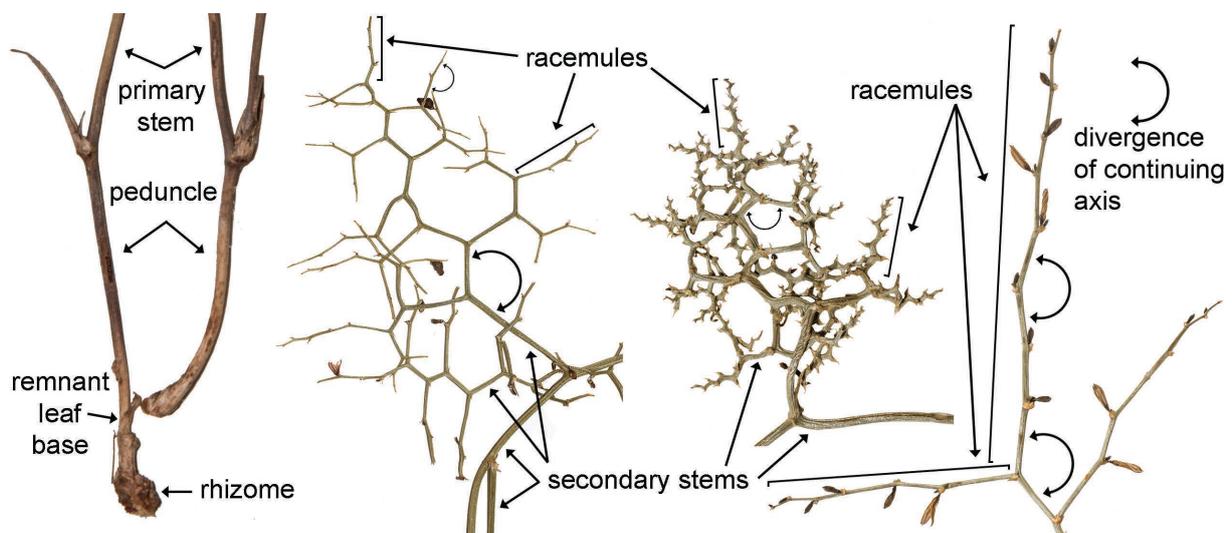
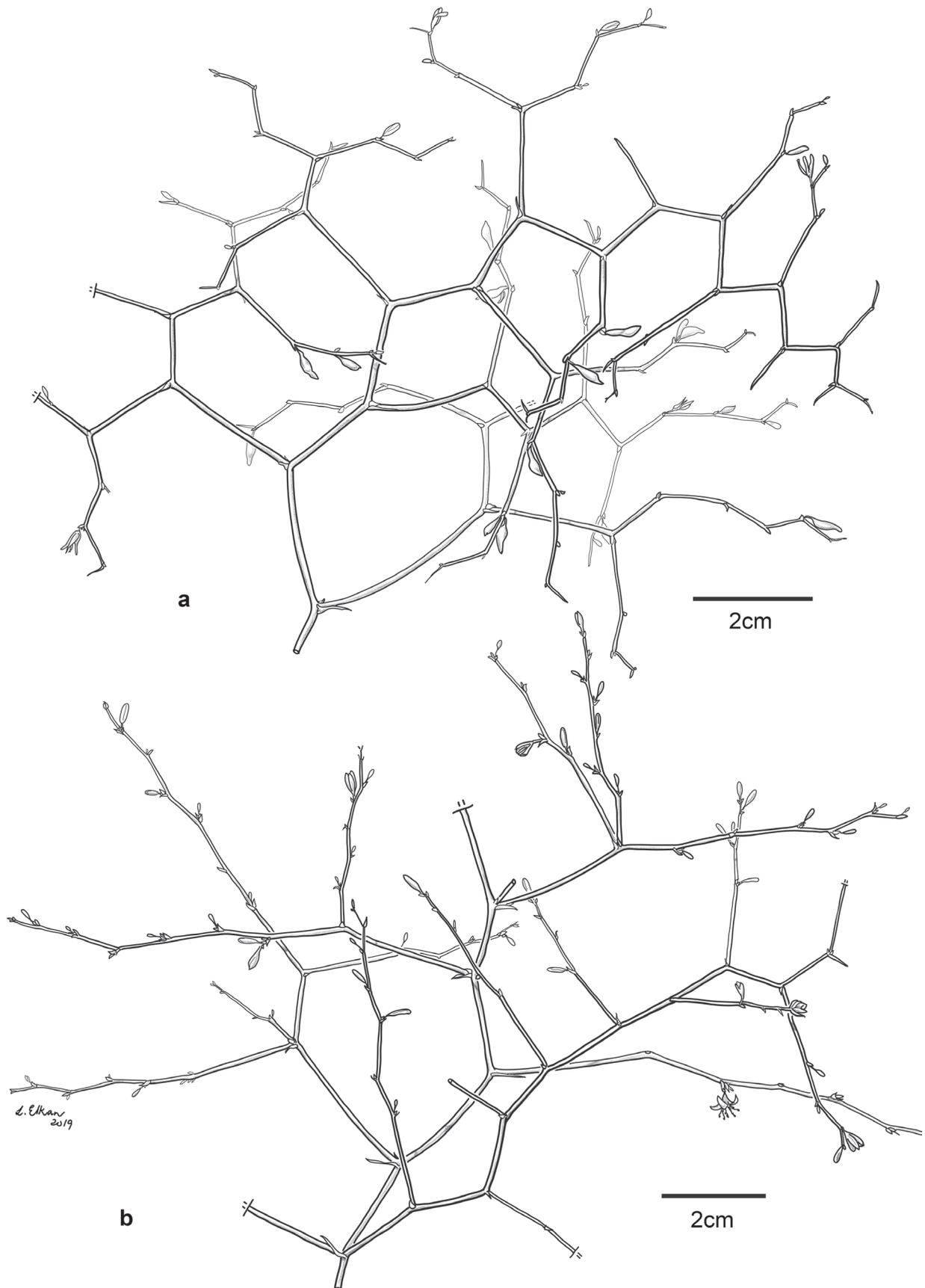
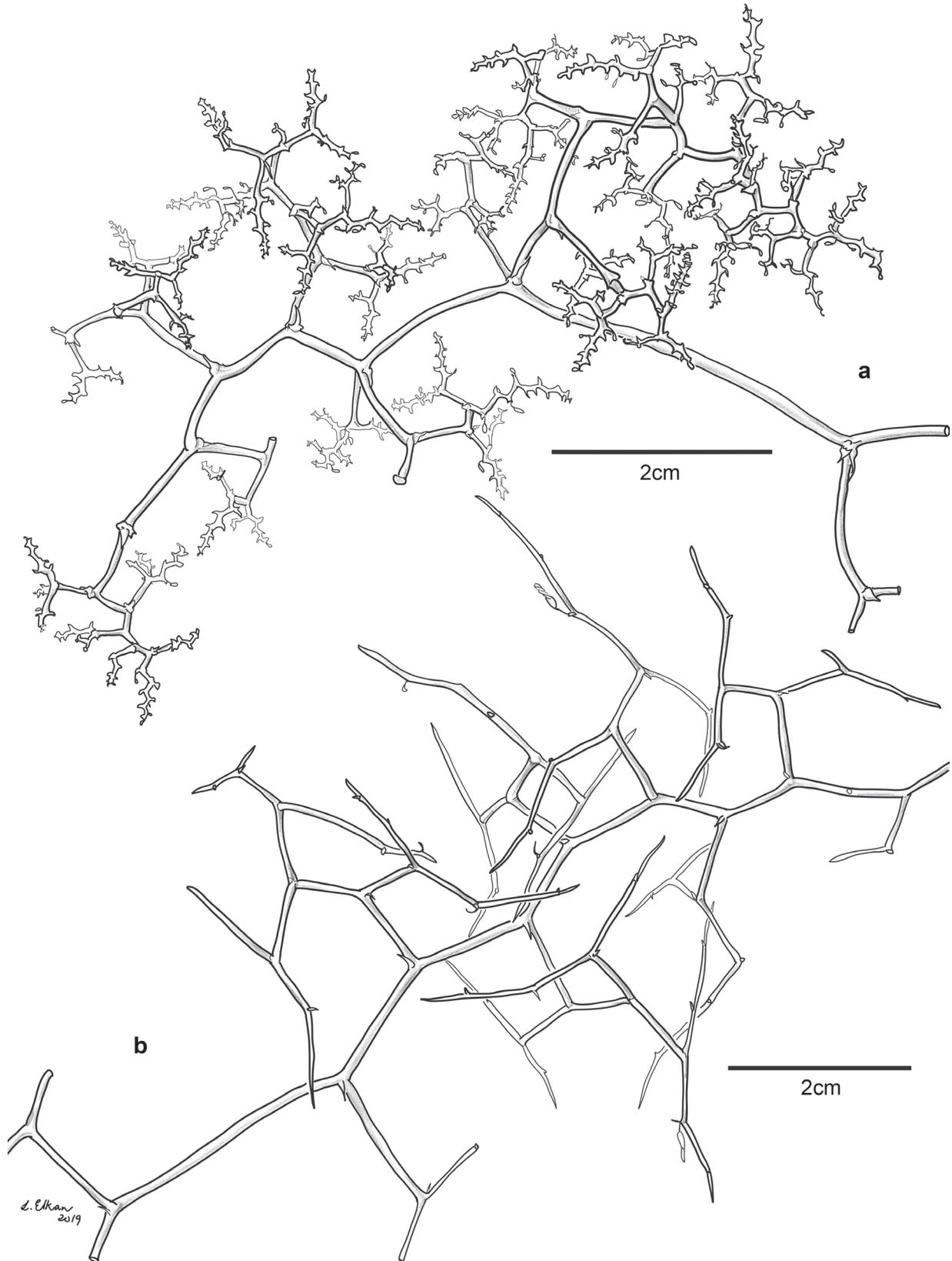


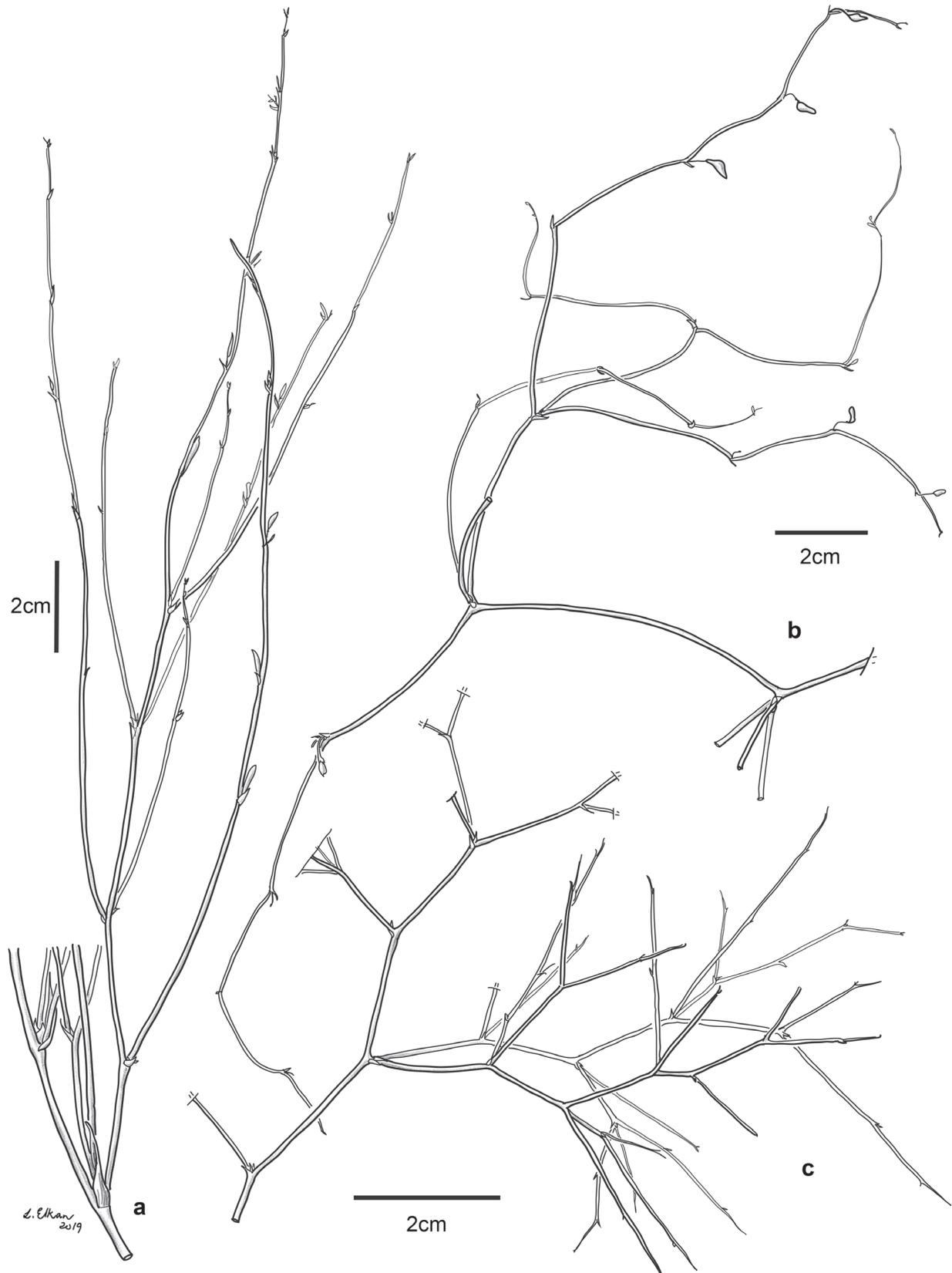
Fig. 1. Key features used in descriptions and for identification of *Corynotheca* species.



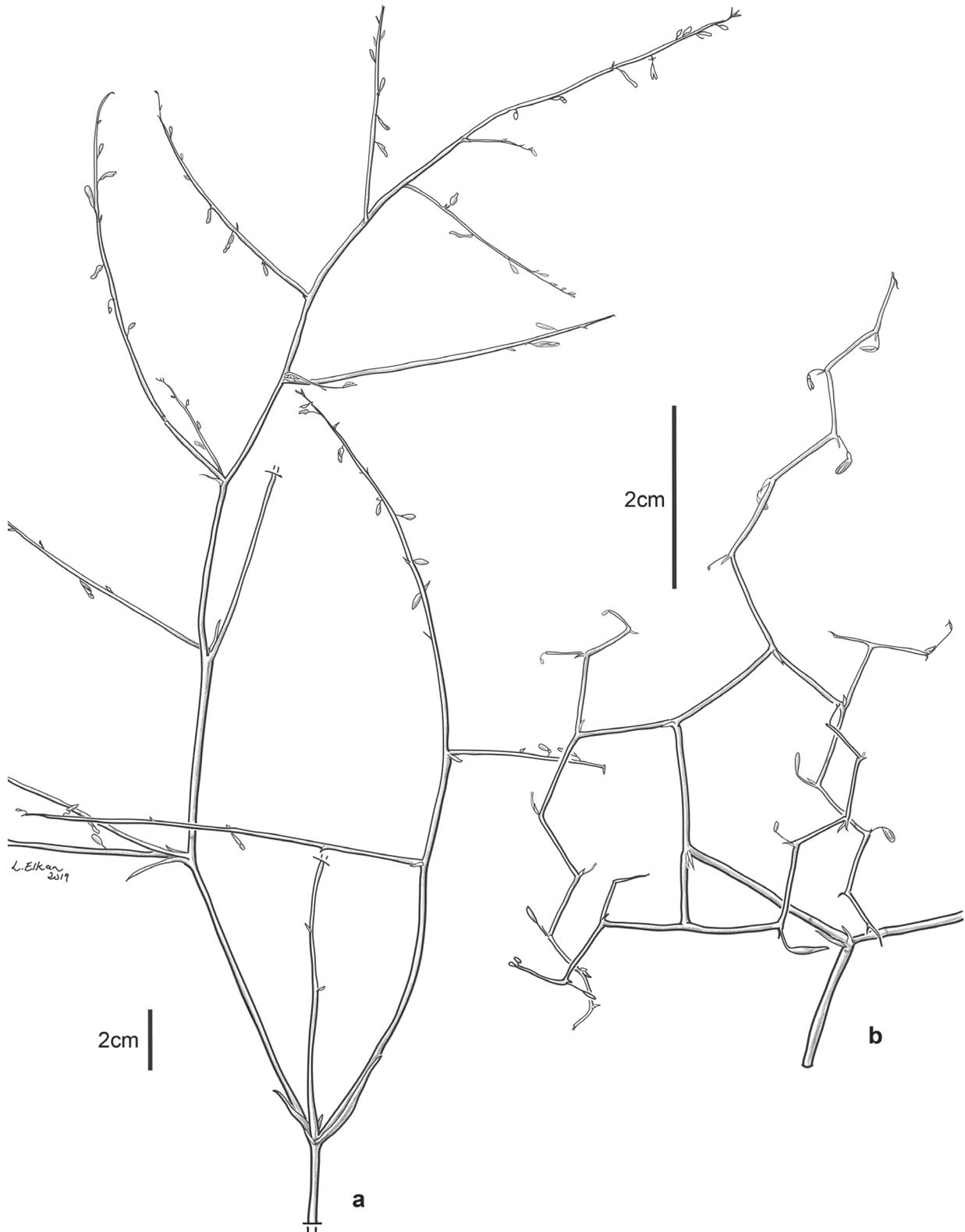
**Fig 2.** Line illustrations of *Corynotheca* branchlets. A. *Corynotheca divaricata* form 1. B. *Corynotheca divaricata* form 2. Vouchers: A: Waite Creek, N. Henry 365 (NSW); B: Finke Settlement, D.E. Albrecht 5640 (NSW). Illustrations by L. Elkan.



**Fig. 3.** Line illustrations of *Corynotheca* branchlets. A. *Corynotheca flexuosissima*. B. *Corynotheca micrantha*. Vouchers: A: Cape Range, A.S. George 10309 (NSW); B: Gingin Brook, N.T. Burbidge 8048 (NSW). Illustrations by L. Elkan.



**Fig. 4.** Line illustrations of *Corynotheca* branchlets. A. *Corynotheca lateriflora*. B. *Corynotheca panda*. C. *Corynotheca gracilis*. Vouchers: A: Goyder River, C.R. Dunlop 8680 & N.G. White (NSW); B: Mount Arid, A.N. Rodd 5144 (NSW); C: Dampier Peninsula, E. Mjoberg s.n. (NSW 109422). Illustrations by L. Elkan.



**Fig. 5.** Line illustrations of *Corynotheca* branchlets. A. *Corynotheca pungens*. B. *Corynotheca dichotoma*. Vouchers: Gascoyne River, E.N.S. Jackson 3092 (NSW); B: Murchison River, W.R. Barker 2191 (NSW). Illustrations by L. Elkan.

## Taxonomy

***Corynotheca*** F.Muell. ex Benth., *Fl. Austral.* 7: 49 (1878), *non* Ochyra (1990; Funariaceae).

Type species: *Corynotheca lateriflora* (R.Br.) Benth., designated by R.J.F.Henderson, *Fl. Austral.* 45: 473 (1987).

*Caesia* sect. *Corynotheca* F.Muell., *Fragm.* 1: 215 (1859), *nom. nud.*

*Corynotheca* F.Muell., *Fragm.* 7: 68 (1870), *nom. prov.*, *nom. nud.*

Tufted, tangled, rhizomatous *perennials*, herbaceous or shrub-like, usually glabrous, occasionally scabrous. *Roots* many, fibrous or fleshy-fibrous, often sand-binding. *Stems* short, subterranean, perennial, bearing leaves and inflorescences. *Leaves* few, linear-subulate, flat or sometimes convolute, reducing rapidly to bracts upwards, all usually senesced by anthesis, but long and persistent in a few species, margins usually glabrous (sometimes scabrid hairs present on *C. pungens*). *Inflorescence* perennating, irregularly paniculate, interrupted, evenly diffuse, dark to dull green; peduncle erect to ascending, subterranean at base; major branches  $\pm$ straight, erect, ascending or decumbent; panicle branches often  $\pm$ divaricate; racemules with axis often tortuous, with 0–21 nodes, sometimes reduced to a spine-like axis, finely ribbed, but otherwise usually smooth, sometimes scabrid or crenulate; apex tapering and tip acute or  $\pm$ pungent in two species; internodes  $\pm$ straight to curved; flowers bisexual,  $\pm$ regular, solitary or paired (rarely 3), and of different ages, in branch axils, pedicellate; lower bracts linear-subulate, acuminate, occasionally long and leaf-like; uppermost bracts obovate or ovate-attenuate to  $\pm$ triangular or minute and needle-shaped. *Perianth* segments shortly connate at base, spirally twisting after anthesis, deciduous. *Sepals* narrowly elliptic to oblong or linear, apex apiculate, with tepal apex trichomes, white or pink to purplish to brown, median band darker, veins purplish to brown. *Petals* narrowly elliptic to oblong, acute or obtuse, white to cream to pale mauve or pink, median band darker, veins purplish to brown. *Stamens* 6, epipetalous; filaments straight or slightly incurving, sometimes kinked (commonly so when immature), alternately unequal or subequal and then the antepetalous ones longer, minutely papillose, white or yellow; anthers basifixed, introrse, becoming extrorse, dehiscent by longitudinal slits, yellow; pollen polychotomosulcate, triangular to rounded triangular, *c.* 17  $\mu$ m diam. *Ovary* superior, 3-locular; ovules 2 per loculus, 1 erect, 1 pendulous; style filiform, shorter than,  $\pm$ equal to or exceeding stamens; stigma capitate, minute. *Fruit* capsule-like and late-dehiscent or nut-like and irregularly rupturing, spreading to pendulous or antrorse, rarely ascending, obpyriform to clavate-attenuate, ovoid or obovoid, brown, usually slightly wrinkled. *Seeds* 1–3 per fruit, ellipsoidal, usually glossy black to iridescent, longitudinally striate or rarely smooth to very finely pitted; caruncle conical distally, the lobes free or fused.

**Diagnostic characters:** *Corynotheca* is distinguished from *Caesia* by subterranean stems with fleshy-fibrous roots (*vs* stem absent, roots fleshy or swollen), leaves usually rapidly senesced (persistent in a few species) the perennating inflorescences with a shrub-like appearance (*vs* annual), inflorescence many-branched and variously divaricate (*vs*  $\pm$ racemose; not or few-branched and straight), short pedicels to 3.4 mm long (*vs* 3–15 mm long), capsules not or irregularly lobed (*vs* consistently 3-lobed) and ellipsoid seeds (*vs* globose) and seeds with a thick caruncle (*vs* a papery aril).

**Distribution:** A genus of 13 species, widespread across much of Australia, endemic, but absent from the far north-east and far south-east mainland (occurring only in the arid zones of Queensland, New South Wales and Victoria) and Tasmania.

**Common names:** Zigzag Lily, Sand Lily.

**Etymology:** The specific epithet is from the Greek *koryne* (a club) and *theke* (a case), in reference to the shape of the fruit.

**Affinities:** *Corynotheca* is generally assumed on morphological similarity to be most closely related to *Caesia* R.Br., sharing polychotomosulcate pollen (Furness *et al.*, 2014). The two genera differ as noted under diagnostic characters. Based on molecular phylogenetic data, these two genera belong in a clade that also includes *Arnocrinum*, *Hensmania*, *Hodgsoniola*, *Johnsonia* and *Stawellia*, this clade being sister to *Tricoryne*, a genus sometimes confused with *Corynotheca* in the absence of flowers, which differs in having bearded staminal filaments and yellow (rarely almost white) flowers. Four *Corynotheca* species assessed have  $2n = 42$ , while two *Caesia* species have  $2n = 28$  or  $56$  respectively, and *Arnocrinum* has  $2n = 24$  (Keighery 1984). These, and a number of related Australian genera, may be buzz-pollinated (Keighery 1984; Furness *et al.*, 2014).

**Notes:** *Corynotheca* species may form large clones in their favoured habitats. Excavation of stands of *C. flexuosissima* and *C. pungens* found that many plants are apparently connected by underground, spreading rhizomes (G.J.Keighery, pers. obs.).

Table 1. Morphological characters considered diagnostic for *Corynotheca* species and general distribution.

	<i>acanthoclada</i>	<i>asperata</i>	<i>borealis</i>	<i>dichotoma</i>	<i>divaricata</i>	<i>elongata</i>	<i>flexuosissima</i>	<i>gracilis</i>	<i>lateriflora</i>	<i>licrota</i>	<i>micrantha</i>	<i>panda</i>	<i>pungens</i>
Habit	erect to spreading	spreading	erect to spreading	spreading	spreading	spreading	spreading	spreading	erect	erect	spreading	spreading to decumbent	erect to spreading
Roots	fibrous	fibrous	not seen	fleshy-fibrous	fleshy-fibrous	fleshy-fibrous	fleshy-fibrous	fibrous	fleshy-fibrous	fibrous	fleshy-fibrous	fleshy-fibrous	fleshy-fibrous
Mature leaves	dry at anthesis	dry at anthesis	dry at anthesis	dry at anthesis	dry at anthesis	dry at anthesis	dry at anthesis	dry at anthesis	dry at anthesis	persistent, basal	dry at anthesis	dry at anthesis	persistent, mostly cauline, margins sometimes with scabrid hairs
Basal leaf length (often bract-like)	8–48 mm	<30 mm	6–25 mm	10–67 mm	14–68 mm	5–34 mm	12–23 mm	7–15 (-20) mm	(40–)120–220 mm	50–300 (-600) mm	28–105 mm	45–180 mm	40–110 mm
Basal leaf width	0.4–1.0 mm	not seen	0.4–0.7 mm	0.8–1.5 mm	1.6–2.9 mm	0.8–1.7 mm	0.6–1.1 mm	0.5–0.8 (-1.1) mm	0.6–2.2 mm	2.5–4.1 (-9) mm	0.6–1.6 mm	0.7–1.6 mm	0.5–2 mm
Basal leaf shape in section	flat	flat	flat	flat	flat	flat	flat	flat	flat to convolute	flat or complicate	flat	flat	flat
Panicle branch angle	170–180°	140–170°	90–160°	80–140°	90–140°	90–150°	80–150°	90–150°	90–150°	130–160°	80–150°	(90–)130–170°	90–150°
Racemule length	4–27 mm	4–23 (-50) mm	10–75 mm	15–60 mm	17–95 mm	37–78 mm	4–12 (-25) mm	20–60 mm	65–175 mm	75–300 mm	12–40 mm	18–106 mm	30–140 (-300) mm
Nodes per racemule	0 or 1	(0)1–6	1–5	(1–)5–13	5–8(-10)	4–8	(5–)9–20	2–5	4–7	5–17	2–4	(2–)5–8	5–21
Racemule branch angle	90–110°	140–180°	80–100°	80–110°	140–180°	(160–)170–180°	90–150°	110–140°	170–180°	±180°	130–180°	140–180°	170–180°
Racemule axis	finely scabrid	scabrid	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth
Racemule internode length	2–4.5 mm, ±straight	2–11 mm, gently curving	5–11 mm, ±straight	1–7 mm, ±straight	4–13 mm, ±straight	4–13(-20) mm, ±straight	0.8–2 mm, straight to gently curving	5–23 mm, ±straight	7–31 mm, ±straight	4–24 mm, ±straight	4–12 mm, straight to gently curving	8–19 mm, ±straight to evenly curving	3–14 mm, ±straight
Racemule diam.	0.3–0.5 mm	0.5–0.7 mm	0.2–0.4 mm	(0.2–)0.4–0.6 mm	0.4–0.9 mm	0.2–0.5 mm	0.2–0.6 mm	0.2–0.4 mm	0.1–0.6 mm	0.4–1.3 mm	0.3–0.6 mm	0.3–0.7 mm	0.6–1.1 mm

	<i>acanthoclada</i>	<i>asperata</i>	<i>borealis</i>	<i>dichotoma</i>	<i>divaricata</i>	<i>elongata</i>	<i>flexuosissima</i>	<i>gracilis</i>	<i>lateriflora</i>	<i>licrota</i>	<i>micrantha</i>	<i>panda</i>	<i>pungens</i>
Upper bract apex	acuminate	acuminate	acuminate	acuminate	acute	acuminate	acuminate	acuminate	acuminate, sometimes stiff	acuminate	acuminate	acuminate	stiff, #pungent
Flowers	1–3	solitary (or rarely paired?)	solitary	solitary	solitary or paired (rarely 3)	solitary	solitary	solitary	solitary	solitary (or rarely paired)	solitary	solitary or paired	solitary
Proportion of flowers developing	few–most	?few	?most	?most	most	?most	?few	few–most	most	most	most	?few	?few–most
Pedical length	0.3–0.7 mm	0.3–0.8 mm	0.9–1.3 mm	0.8–2.3 mm	0.3–1.2 mm	0.8–1.9 mm	0.2–0.9 mm	1.0–3.1 mm	1.4–2.0 (–3.0) mm	1.2–2.6 mm	1.2–2.9 mm	1.3–2.9 (–3.4) mm	0.9–1.7 mm
Perianth length	1.5–1.7 mm	4.5–6.3 mm	3.9–5.0 mm	4.1–5.0 mm	4.5–5.9 mm	3.1–4.3 mm	1.4–2.1 mm	4.0–6.5 mm	6.5–8.0 mm	4.3–6.0 mm	2.8–4.5 mm	3.5–4.6 mm	2.7–6.1 mm
Staminal filaments	erect, subequal, white	not seen	slightly spreading, unequal, yellow	spreading, subequal, white	slightly spreading, unequal, yellow	erect, subequal, white	erect, subequal, white	slightly spreading, unequal, yellow	slightly spreading, unequal, yellow	slightly spreading, yellow	erect, subequal, white	slightly spreading, subequal, white	Erect to spreading, subequal to equal, yellow
Staminal filament length	0.6–0.7 mm	not seen	1.4–2.1 mm	2.2–2.7 mm	1.4–1.8 mm	1.8–2.5 mm	0.6–0.8 mm	1.9–4.0 mm	3.2–4.1 mm	1.7–2.2 mm	1.7–2.1 mm	1.7–2.0 mm	2.1–2.6 mm
Seed length	1.9–2.4 mm	not seen	3.8–4.2 mm	2.9–3.3 mm	2.3–3.7 mm	1.8–2.7 mm	1.8–2.1 mm	3.4–4.7 mm	5.0–6.8 mm	3.0–4.3 mm	2.3–3.4 mm	2.8–3.3 mm	2.7–2.9 mm
Caruncle lobes	fused, colliculate	not seen	fused, colliculate	fused, colliculate	fused, colliculate	fused, colliculate	fused, colliculate	fused, colliculate	free, colliculate	free, folded	fused, colliculate	fused, colliculate	fused, colliculate
Testa surface	striate	not seen	striate	striate	smooth to very finely pitted	striate	striate	striate	striate	smooth to finely striate	striate	striate	(smooth to) striate
Testa appearance	glossy	not seen	glossy	glossy	very glossy	glossy	glossy	glossy	glossy	glossy	glossy	glossy	glossy
Distribution	Kalbarri to Greenough, WA	Great Sandy Desert, WA; Tanami, NT	Karunji Station, WA to Keep River, NT	Mullewa, to Shark Bay and Dirk Hartog Island, WA	Wiluna, WA, central NT, N of SA, to Springvale SE Qld	Eneabba to Dunsborough, inland to Lake King, WA	Cape Range to Onslow, WA	Broome and Mandora to Ngumban Cliffs, to Kiwirrkura, WA	Top End, Gulf of Carpentaria, NT	Arid zone, WA, NT, SA, Qld, NSW, Vic.	Eneabba to Dunsborough, inland to Williams, WA	Blackwood River to Cape Arid, WA	Port Headland to Shark Bay, inland to Newman, WA

*Corynotheca* is one of numerous Australian Asparagoid genera with tepal apex trichomes (Macfarlane and Conran 2016). These structures are particularly well-developed in *Corynotheca*, forming a conspicuous hook-like subterminal appendage on the sepals (see flower images in this paper, e.g. Figs 14B, 17D). Henderson (1987) refers to them as adaxial appendages on the sepals and illustrates them in his Fig. 96E. Macfarlane and Conran (2016) suggest that these structures, which by adhesion between the trichomes of different sepals (and petals, where they are less conspicuous) hold the buds closed until anthesis, may function by controlling the timing or enhancing the rapidity of flower opening. *Corynotheca* species have more or less synchronous opening of flowers, often late in the day (Eichler 2018). In the only well-studied example of flower behaviour in a species with tepal apex trichomes, the Californian *Chlorogalum pomeridianum* (DC.) Kunth, Stockhouse and Wells (1978) suggested that rapid flower opening, which occurs at about the same time each day, may concentrate pollinator visitation and hence promote effective pollination and outcrossing.

Previous treatments have stated that anther filaments in *Corynotheca* are all of equal length, differing from *Caesia* in this regard, however field observations and photographs show that filaments are usually of two distinct lengths, or a few species are subequal. The thickened portion of the filaments is usually greater in the longest filaments, the shorter filaments often only being thickened in the lower half.

*Caesia micrantha* has similarly striate seeds, however other generic characters listed above readily separate this species from *Corynotheca*. Thickened caruncles are found in *Caesia viscida* Keighery and related taxa, which have superficially similar habits to *Corynotheca licrota*, but phylogenetic data place *Ca. viscida* within *Caesia* s. str. and *Co. licrota* within *Corynotheca* s. str. (A. Webb, B. Gunn and J. Birch, pers. comm.).

Table 1 presents a range of morphological characteristics useful for distinguishing between *Corynotheca* species.

### Key to species of *Corynotheca*

1. Perianth 6.5–8.0 mm long; leaves (40–)120–220 mm long; seeds 5.0–6.8 mm long  
(Top end, Gulf of Carpentaria, NT)..... *C. lateriflora*
- 1: Perianth 1.4–6.5 mm long; leaves 5–110(–300) mm long; seeds 1.8–4.7 mm long ..... 2
2. Inflorescence axes and racemules finely scabrid; pedicels 0.3–0.8 mm long  
(Great Sandy Desert, WA; Tanami, NT) ..... *C. asperata*
- 2: Inflorescence axes and racemules smooth, ribbed or crenulate; pedicels 0.8–2.9(–3.4) mm long  
(except for *C. flexuosissima*; pedicels 0.2–0.9 mm long and *C. divaricata*; pedicels 0.3–1.2 mm long) ..... 3
3. Mature basal leaves persistent at anthesis, 2.5–4.1(–9) mm wide; racemules consistently  
continuous at  $\pm 180^\circ$  (i.e. straight); caruncle lobes free (Arid zone, WA, NT, SA,  
Qld, NSW, Vic.) ..... *C. licrota*
- 3: Mature basal leaves mostly dry at anthesis, 0.6–2.2(–2.9) mm wide; racemules usually  
diverging at  $80\text{--}170^\circ$  (*C. elongata* & *C. pungens* often almost straight); caruncle lobes fused ..... 4
4. Plants with mature cauline leaves not reduced to bracts, persistent, clustered in major axils,  
margins sometimes with scabrid hairs; upper bract apices stiff,  $\pm$ pungent; racemules  
0.6–1.1 mm diam. (Port Headland to Shark Bay, inland to Newman, WA) ..... *C. pungens*
- 4: Plants with leaves all basal, dry at anthesis, reduced to bracts above, margins glabrous;  
upper bract apices acuminate to acute, but not pungent; racemules 0.2–0.9 mm diam..... 5
5. Racemules 4–12(–25) mm long, with (5–)9–20 nodes, internodes 0.8–2 mm long,  
inflorescence with a dense, gnarled appearance; perianth 1.4–2.1 mm long  
(Cape Range to Onslow, WA) ..... *C. flexuosissima*
- 5: Racemules (4–)10–300 mm long, with 0–8(–13) nodes, internodes 2–23 mm long;  
inflorescence open to somewhat dense, not gnarled; perianth 2.8–8.0 mm long ..... 6
6. Seed testa smooth to very finely pitted; pedicels 0.3–1.2 mm long; basal leaves 1.6–2.9 mm  
wide (Wiluna, WA, central NT, N of SA, to Springvale SE Qld) ..... *C. divaricata*
- 6: Seed testa longitudinally striate; pedicels 0.8–2.9(–3.4) mm long; basal leaves 0.4–1.7 mm wide ..... 7
7. Racemules with 0–5 internodes (always some <4) ..... 8
- 7: Racemules with 4–13 internodes (always some >5) ..... 11
8. Inflorescence branches stiff; racemules  $\pm$ stiffly straight or sometimes diverging, pungent,  
4–27 mm long (Kalbarri to Yandanooka (S of Mingenew), WA) ..... *C. acanthoclada*

- 8: Inflorescence branches flexible, racemules slender,  $\pm$ flexible, straight to diverging, not pungent, 10–75 mm long ..... 9
- 9: Racemule internodes diverging at 130–180°, 0.3–0.6 mm wide; perianth 2.8–4.5 mm long; basal leaves 28–105 mm long; seeds 2.3–3.4 mm long (Eneabba to Dunsborough, inland to Williams, WA) ..... *C. micrantha*
- 9: Racemule internodes diverging at 80–140°, 0.2–0.4 mm wide; perianth 3.9–6.5 mm long; basal leaves 6–25 mm long; seeds 3.4–4.7 mm long ..... 10
- 10: Racemule internodes diverging at 80–100°; pedicels 0.9–1.3 mm long; staminal filaments 1.4–2.1 mm long (Karunji Station, WA to Keep River, NT) ..... *C. borealis*
- 10: Racemule internodes diverging at 110–140°; pedicels 1.0–3.1 mm long; staminal filaments 1.9–4.0 mm long (Broome to Ngumban Cliffs, to Kiwirrkura, WA) ..... *C. gracilis*
- 11: Racemule with (1–)5–13 internodes, diverging at 80–110°, internodes 1–7 mm long (Mullewa, to Shark Bay and Dirk Hartog Island, WA) ..... *C. dichotoma*
- 11: Racemule with (2–)5–8 internodes, diverging or straight (140–180°), internodes 4–19(–20) mm long ..... 12
- 12: Basal leaves 5–34 mm long; racemule internodes diverging at (160–)170–180°; internodes 4–13(–20) mm long, 0.2–0.5 mm diam.,  $\pm$ straight; seeds 1.8–2.7 mm long (Eneabba to Dunsborough, inland to Lake King, WA) ..... *C. elongata*
- 12: Basal leaves 45–180 mm long; racemule internodes diverging at 140–180°; internodes 8–19 mm long, 0.3–0.7 mm diam.,  $\pm$ straight to evenly curving; seeds 2.8–3.3 mm long (Blackwood River to Cape Arid, WA) ..... *C. panda*

*Corynotheca acanthoclada* (F.Muell.) F.Muell. ex Benth., *Fl. Austral.* 7: 50 (1878); *Caesia acanthoclada* F.Muell., *Fragm.* 1(9): 215 (1859); *Corynotheca micrantha* var. *acanthoclada* (F.Muell.) R.J.F.Hend., *Fl. Austral.* 45: 474 (1987).

Type: near Murchison River, Western Australia, *n.d.*, *A.F. Oldfield s.n.* [?1095] (lecto, first step designated by R.J.F.Henderson *Fl. Austral.* 45: 302, 474 (1987), second step designated here: MEL 107030; isolecto: K 000794729\*, K 000794730\*, K 000794731\*, MEL 107029).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* several, 30–70 mm long, fibrous, not sand-binding. *Stems* short, to 10 mm long and 4 mm wide. *Leaves* few, linear-subulate, 8–48 mm long, 0.4–1.0 mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, interrupted, evenly diffuse, to 37 cm long, olive-green; peduncle erect to ascending, subterranean at base; major branches  $\pm$ straight, erect or ascending; lowest branch 0–1.5 cm from rhizome; panicle branches  $\pm$ straight, each node divaricate at 170–180°; racemules with axis not tortuous, 4–27 mm long, with 0 or 1 nodes, each node diverging at 90–110°, but commonly reduced to a spine-like axis 4–27 mm long, ribbed to narrowly winged, very finely covered in blunt, scabrid hairs 0.05–0.15 mm long; apex tapering and tip pungent; internodes 2–4.5 mm long, 0.3–0.5 mm wide,  $\pm$ straight; flowers 1–3 in branch axils, few–most developing; lower bracts linear-subulate, 3–15 mm long, acuminate; uppermost bracts obovate to  $\pm$ triangular, 0.8–1.2 mm long; pedicels 0.3–0.7 mm long. *Perianth* 1.5–1.7 mm long, segments connate for *c.* 0.1 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly oblong, 1.5–1.7 mm long, 0.6–0.7 mm wide, apex apiculate, with a minute appendage *c.* 0.05 mm long, pink to purplish to brown, margins white adaxially, median band darker. *Petals* narrowly oblong, 1.5–1.6 mm long, 0.5–0.6 mm wide, acute, white to cream, median band darker abaxially. *Filaments* held erect, straight or slightly incurving, subequal, 0.6–0.7 mm long, slightly dilated, minutely papillose, white; anthers *c.* 0.25 mm long. *Style* filiform, to 0.7 mm long, *c.* equal to stamens. *Capsule* spreading to pendulous, obpyriform, 2.0–2.6 mm long, 1.1–1.5 mm wide, brown, slightly wrinkled. *Seed* 1 per fruit, 1.9–2.4 mm long, *c.* 1.6 mm wide, glossy black to iridescent, longitudinally striate; caruncle conical distally, the lobes fused (Figure 6).

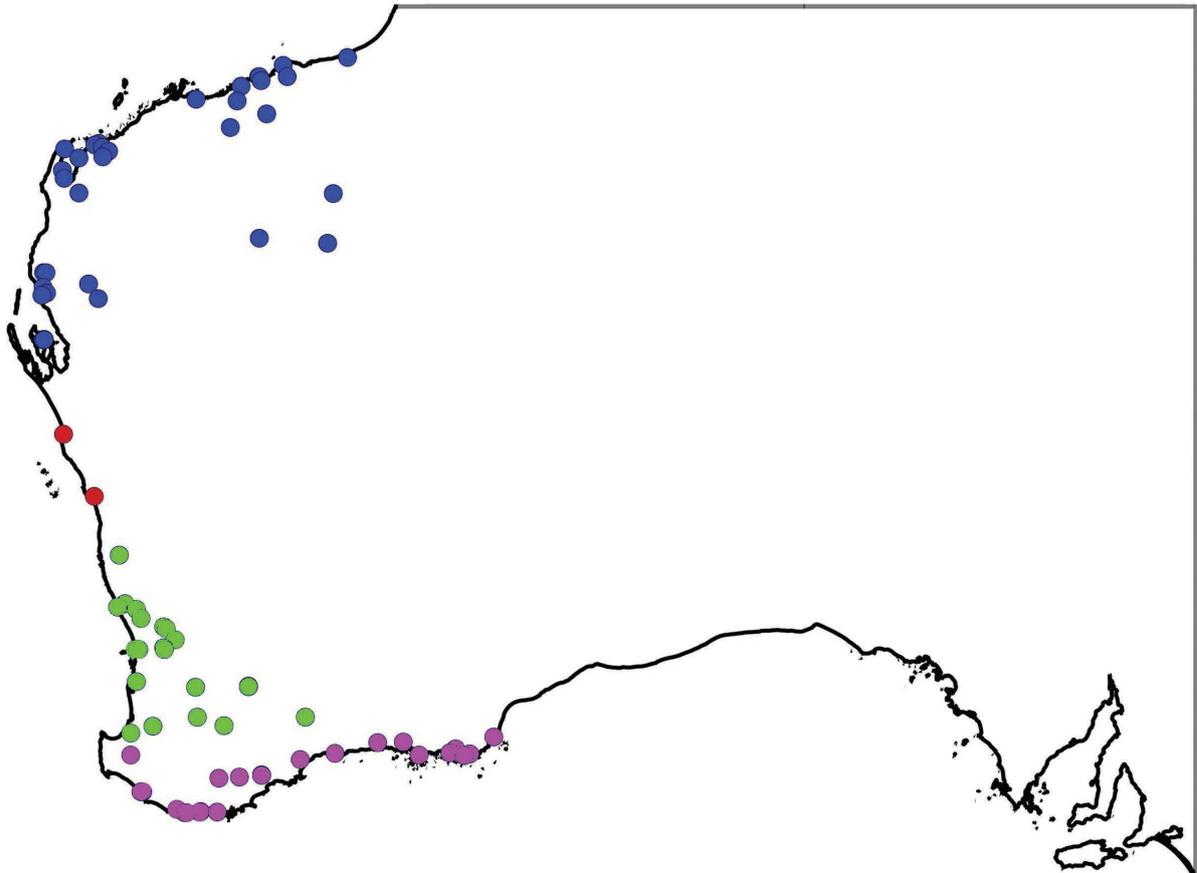
**Diagnostic characters:** Inflorescence branches stiff; racemules with 0 or 1 nodes,  $\pm$ stiffly straight or sometimes diverging, pungent, 4–27 mm long, ribbed to narrowly winged, very finely covered in blunt, scabrid hairs 0.05–0.15 mm long.



**Fig. 6.** *Corynotheca acanthoclada*. A. Habit. B–D. Flowering branchlets. E. Lateral view of flower and buds. F. Flower and buds. Vouchers: Kalbarri, J. Jackson & R. Simkin s.n. (PERTH, A–D); Kalbarri, R. Simkin s.n. (PERTH, E, F). Photographs by J. Jackson (A–D); R. Simkin (E, F).

**Other specimens examined:** WESTERN AUSTRALIA: [Precise localities withheld for conservation reasons] Kalbarri, 30 Dec. 1988, *D. & B. Bellairs 2130* (PERTH); Kalbarri National Park, 10 Oct. 2019, *J. Jackson & R. Simkin s.n.* (PERTH); Greenough River, Oct. 1877, *F. Mueller s.n.* (MEL 107027, MEL 107028); Greenough River, Nov. 1877, *F. Mueller s.n.* (MEL 107031, MEL 107032); Greenough Back Flats, 20 Aug. 1998, *M.H. O'Connor MOC 0193* (PERTH); near West Binu, 5 Oct. 2019, *R. Simkin s.n.* (PERTH); near Yandanooka, Nov. 1998, *R. Soullier 632* (PERTH).

**Distribution:** Restricted to near-coastal areas near Kalbarri, along the Murchison River, West Binu, Yandanooka, and the Greenough Flats in Western Australia (Fig. 7).

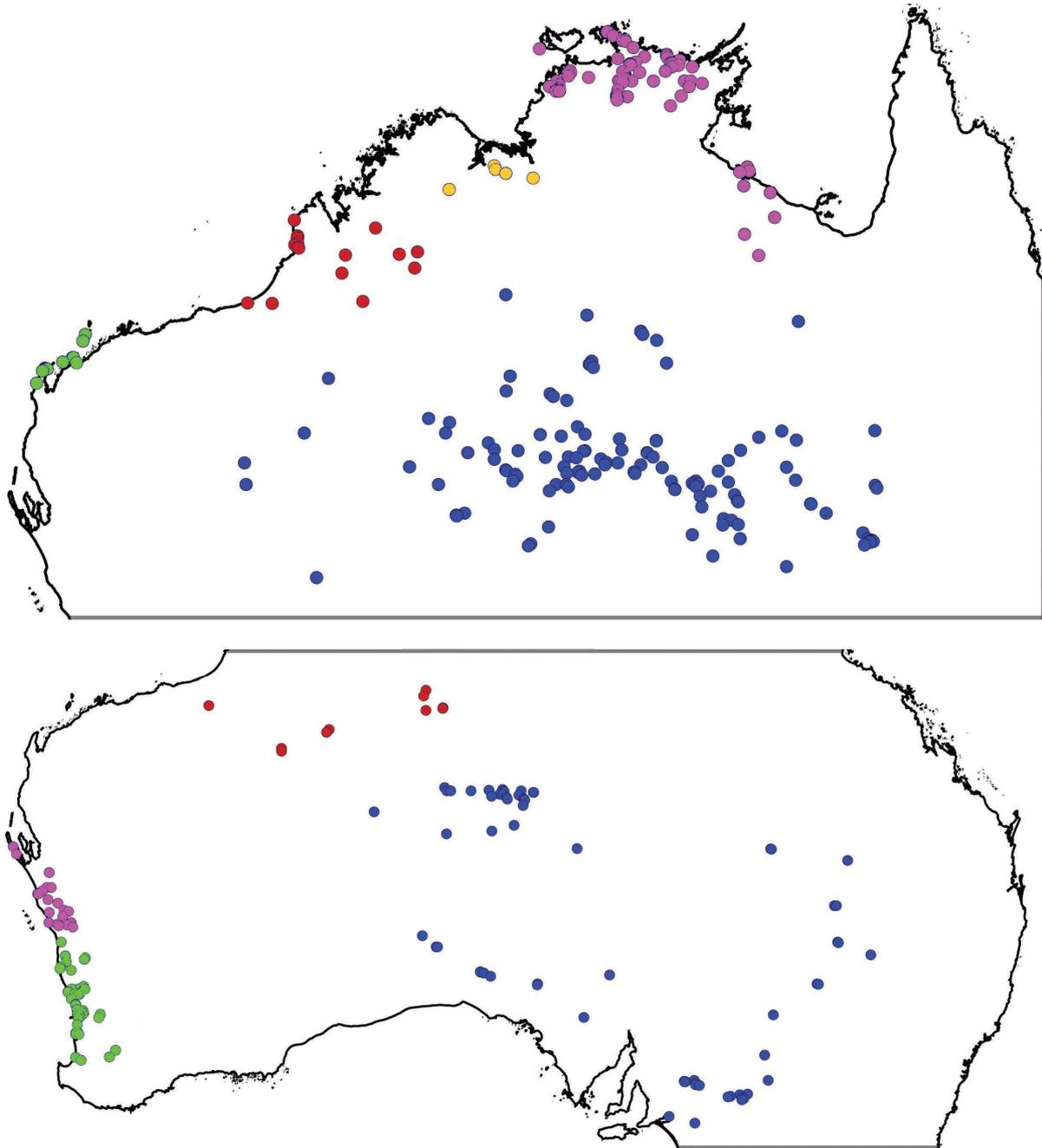


**Fig. 7.** Distribution map for *Corynotheca* species. *C. acanthoclada* (red); *C. elongata* (green); *C. panda* (pink); *C. pungens* (blue).

**Habitat:** Grows in sand over limestone, and white, yellow, brown or grey sandy alluvial loam over sandstone, in very open, low heath with scattered taller shrubs or open to closed shrubland. Most commonly seen post-fire or in areas that have been disturbed, such as roadsides, 1–4 years post-disturbance. Recorded in association with *Acacia acuminata*, *A. scirpifolia*, *Adenanthos cygnorum*, *Allocasuarina campestris*, *Banksia attenuata*, *Callitris arenaria*, *Chamelaucium marchantii*, *Cyphanthera racemosa*, *Cryptandra* sp., *Darwinia pauciflora*, *Daviesia pedunculata*, *Eucalyptus eudesmioides*, *Grevillea leucopteris*, *G. trifurcata*, *Gyrostemon racemiger*, *Lepidobolus* sp., *Melaleuca megacephala*, *Nuytsia floribunda*, *Pimelea angustifolia*, *Scaevola canescens*, *Schoenus* sp., *Scholtzia* spp. and *Stirlingia latifolia*.

**Phenology:** Flowers recorded for October–December.

**Conservation status:** *Corynotheca acanthoclada* is highly localised and it remains poorly collected. One population was recorded as ‘frequent along roadside for c. 200 m’, with a second, small population 400 m away. Another population observed in 2016 could not be relocated in 2018 due to localised disturbance. Several populations are known within Kalbarri National Park. To be listed as Conservation Priority 3 for Western Australian Flora (A. Jones, pers. comm.).



**Fig. 8.** Distribution maps for *Corynotheca* species. Map A (top): *C. borealis* (orange); *C. divaricata* (blue); *C. gracilis* (red); *C. flexuosissima* (green); *C. lateriflora* (pink). Map B (bottom): *C. asperata* (red); *C. dichotoma* (pink); *C. licrota* (blue); *C. micrantha* (green).

**Common name:** Spiny Zigzag Lily.

**Etymology:** The specific epithet is from the Greek *acantho-* (spiny) and *-cladus* (branch, shoot) in reference to the pungent racemule apices.

**Affinities:** *Corynotheca acanthoclada* may be related to *C. micrantha* and *C. elongata*, most readily distinguished from both species by the relatively short racemules that are rigid with pungent apices.

**Notes:** While Mueller (1870: 68) suggested this species might be best placed in a separate genus '*Corynotheca*', the combination was only validated by Bentham (1878: 50) who also validated the genus.

Henderson (1987: 474) designated material at MEL as the lectotype, but as two sheets are present at MEL, a second step lectotype is designated here to select a single sheet.

As a disturbance opportunist, this species may be relatively short-lived (R.Simkin, pers. comm.). It is also possible that it is longer-lived, but quickly overgrown and difficult to find once surrounding vegetation has recovered from the disturbance event.

*Corynotheca asperata* R.J.F.Hend., *Fl. Austral.* 45: 473, 304, fig. 96j (1987).

Type: c. 18 miles [c. 29 km] S of Inningarra Range, Northern Territory, 3 August 1970, *J.R. Maconochie* 939 (holo: BRI AQ0053440; iso: NT A0027837\*).

Tufted, tangled, rhizomatous *perennial*, upper parts scabrous. *Roots* not seen. *Stems* not seen. *Leaves* few, linear-subulate, to 30 mm long, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, to 60 cm long, dark green; peduncle ascending to decumbent, subterranean at base; major branches spreading to decumbent; lowest branch 1–3 cm from rhizome; branching at 80–100°; panicle branches flexuose, each node diverging at 140–170°; racemules with axis tortuous, 4–23(–50) mm long, with (0)1–6 nodes, each node divaricate at 140–180°, but sometimes reduced to 1 internode 4–8 mm long, finely ribbed, scabrid; internodes 2–11 mm long, 0.5–0.7 mm wide, ±straight; flowers solitary (?or rarely paired) in branch axils, ?few developing; lower bracts linear, ±pungent, 5–20 mm long, acuminate; uppermost bracts minute, needle-shaped, 3–4 mm long; pedicels 0.3–0.8 mm long. *Perianth* 4.5–6.3 mm long, segments connate for c. 0.5 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly elliptic to oblong, 4.6–6.2 mm long, 0.9–1.1 mm wide, apex apiculate, with a minute appendage c. 0.5 mm long, pink to purplish to brown, median band darker. *Petals* narrowly elliptic, 4.5–6.1 mm long, 0.8–1.0 mm wide, obtuse, white to cream, median band darker. *Filaments* not examined; anthers 0.8–1.0 mm long. *Style* not examined. *Capsule* not seen (Figure 9).



**Fig. 9.** *Corynotheca asperata*. A. Habit. B. Inflorescence with closed flowers. Voucher: Tanami Downs Station, *D.E. Albrecht* 12673 (NT). Photographs by *D.E. Albrecht*.

**Diagnostic characters:** Inflorescence axes and racemules finely scabrid; pedicels 0.3–0.8 mm long.

**Other specimens examined:** WESTERN AUSTRALIA: [precise localities withheld for conservation reasons] North Pilbara, July 2014, *S. Colwill* & *M. Henson* WB 37311 (PERTH); East Pilbara, May 1979, *A.S. George*

15589 (DNA, *n.v.*, PERTH); East Pilbara, May 1979, A.S. Mitchell 1065 (DNA, *n.v.*, PERTH); NORTHERN TERRITORY: c. 1.5 km S of Wild Potato Bore, Tanami Downs Station, 17 July 2008, D. Albrecht 12673 (DNA, *n.v.*, NT); 8 km S of Sangsters Bore, Tanami Desert, 8 Aug. 1982, P.K. Latz 9388 (AD, DNA, *n.v.*).

**Distribution:** Only known from a few collections along the southern margins of the Great Sandy Desert in Western Australia, and from the adjacent Tanami Desert in the Northern Territory (Figure 8B).

**Habitat:** Grows on red sand dunes with *Acacia torulosa*, *Aristida holathera*, *Chamaecrista symonii*, *Crotalaria cunninghamii*, *Dicrastylis doranii*, *Triodia epectia* and *T. schinzii*.

**Phenology:** Flowers mostly from May–August.

**Conservation status:** *Corynotheca asperata* is listed as Priority Three under conservation codes for Western Australian flora. Listed as Data Deficient in the Northern Territory.

**Common name:** Rough Zigzag Lily.

**Etymology:** The specific epithet is from the Latin *asperatus* (rough with points or sharp stiff hairs), in reference to the sparse, even indumentum of short, stiff, erect hairs on the inflorescence axes.

**Affinities:** *Corynotheca asperata* may be most closely related to *C. divaricata*, sharing a robust habit and arid habitats, differing in the scabrous (*vs* glabrous) inflorescence axes, racemules with (0)1–6 (*vs* 5–8(–10)) nodes and 4–23(–50) (*vs* 17–95) mm long.

**Notes:** Henderson (1987) did not see any material with fruit or seeds and they remain uncollected.

***Corynotheca borealis*** R.L.Barrett, Keighery & T.Macfarlane, *sp. nov.*

Type: Keep River National Park, SW of Jarrnarm, Northern Territory, 19 June 1995, J.L. Egan 5107 (holo: CANB 00531761.1, CANB 00531761.2 [a single specimen mounted on two sheets]; iso: DNA D0123729\*).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* not seen. *Stems* not seen. *Leaves* few, linear-subulate, 6–25 mm long, 0.4–0.7 mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, 45–90 cm long, dark green; peduncle ascending to spreading, subterranean at base; major branches mostly erect; lowest branch 6–20 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 90–160°; racemules with axis not or slightly tortuous, 10–75 mm long, with 1–5 nodes, each node divaricate at 80–100°, finely ribbed, but otherwise smooth; internodes 5–11 mm long, 0.2–0.4 mm wide, ±straight; flowers solitary, most developing, subtended by a small bract; lower bracts ±narrowly triangular, 4–8 mm long, acuminate; uppermost bracts ±triangular, 0.4–0.5 mm long; pedicels 0.9–1.3 mm long (elongating to 2.4 mm long in fruit). *Perianth* 3.9–5.0 mm long, segments connate for 0.6–0.7 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly elliptic to narrowly oblong-elliptic, 4.2–4.5 mm long, 0.8–0.9 mm wide, apex apiculate, with a minute appendage c. 0.3 mm long, cream to brown, median band brown. *Petals* narrowly oblong to narrowly elliptic, 4.1–4.5 mm long, 0.7–0.8 mm wide, obtuse, white to cream, median band darker. *Filaments* slightly spreading, straight or slightly incurving, 1.4–2.1 mm long, unequal, dilated and minutely papillose in lower half, yellow; anthers c. 0.5 mm long. *Style* filiform, to c. 1.8 mm long, not exceeding stamens. *Capsule* antrorse, fusiform to obpyriform to obovate, 4.1–5.2 mm long, 1.8–2.3 mm wide, brown, slightly wrinkled. *Seed* 1 per fruit, 3.8–4.2 mm long, c. 2.0 mm wide, glossy black to brown, longitudinally striate; caruncle conical distally, blackish, the lobes fused (Figure 10).

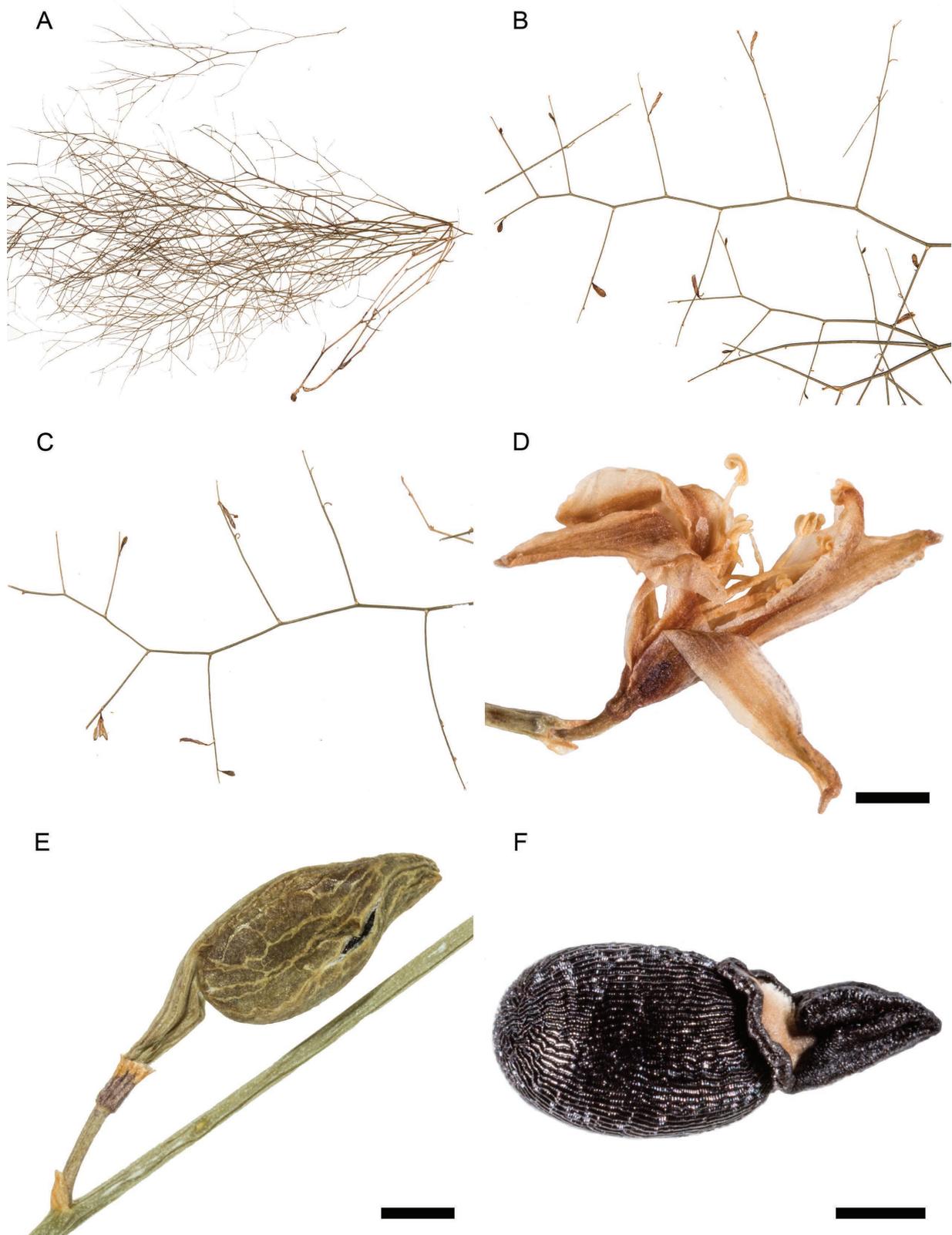
**Diagnostic characters:** Racemule internodes diverging at 80–100°; pedicels 0.9–1.3 mm long; staminal filaments 1.4–2.1 mm long.

**Other specimens examined:** WESTERN AUSTRALIA: Carlton Road, NW, KRS [Kimberley Research Station], Kununurra, 7 Dec. 1978, M.H. Andrew 177 (BRI, CANB, DNA, *n.v.*); 9 mi. E of Kimberley Research Station, 23 July 1949, R.A. Perry 2571 (AD, *n.v.*, BRI, NSW, PERTH); Karunji Station, 7 Mar. 1950, D.W. Rust 88 (CANB, PERTH). NORTHERN TERRITORY: Auvergne Station, 13 Mar. 1998, R. Harwood 450 & P. Brocklehurst (DNA).

**Distribution:** Of restricted distribution near Kununurra, extending south to Karunji Station in Western Australia and from Keep River National Park east to Pelican Creek (Auvergne Station) in the Northern Territory (Figure 8A).

**Habitat:** Grows on red ‘cockatoo’ sand flats in open woodland below sandstone. Associated species include *Acacia tumida* and *Corymbia polycarpa*.

**Phenology:** Flowers between December and June. Fruit recorded in Sept.



**Fig. 10.** *Corynotheca borealis*. A. Habit. B, C. Flowering branches. D. Flower. E. Fruit. F. Seed. Vouchers: A: Karunji Station, *D.W. Rust 88* (CANB); B–F: Keep River National Park, *J.L. Egan 5107* (CANB). Scale = 1 mm. Photographs by R.L. Barrett.

**Conservation status:** *Corynotheca borealis* is poorly known and should be listed as a Priority 1 taxon in Western Australia and Data Deficient in the Northern Territory. Searches for this species in the vicinity of the Kimberley Research Station in January 2021 failed to locate any populations (M.D. Barrett, pers. comm.), but the original collection locations are each somewhat unclear and populations may yet be extant in the area.

**Common name:** Northern Zigzag Lily.

**Etymology:** The specific epithet refers to the northern distribution in relation to its closest relative, *C. gracilis*.

**Affinities:** *Corynotheca borealis* is most closely related to *C. gracilis*, differing in the racemule internodes diverging at 80–100° (vs 110–140°); pedicels 0.9–1.3 mm long (vs 1.0–3.1 mm long); sepals 0.8–0.9 mm wide (vs 1.1–1.4 mm wide), petals 0.7–0.8 mm wide (vs 1.4–1.5 mm wide) and staminal filaments 1.4–2.1 mm long (vs 1.9–4.0 mm long).

**Notes:** This taxon has previously been confused with *C. lateriflora*. *Corynotheca borealis* can be readily distinguished from *C. lateriflora* by the racemules with axis not or slightly tortuous (vs tortuous), 10–75 mm long (vs 65–175(–250) mm long), with 1–5 nodes (vs 4–7), each node divaricate at 80–100° (vs diverging at 170–180°) and internodes 5–11 mm long (vs 7–31(–40) mm long). All previous records of *C. lateriflora* from Western Australia represent either *C. borealis* or *Tricoryne* sp. Kimberley (K.F. Kenneally 4857).

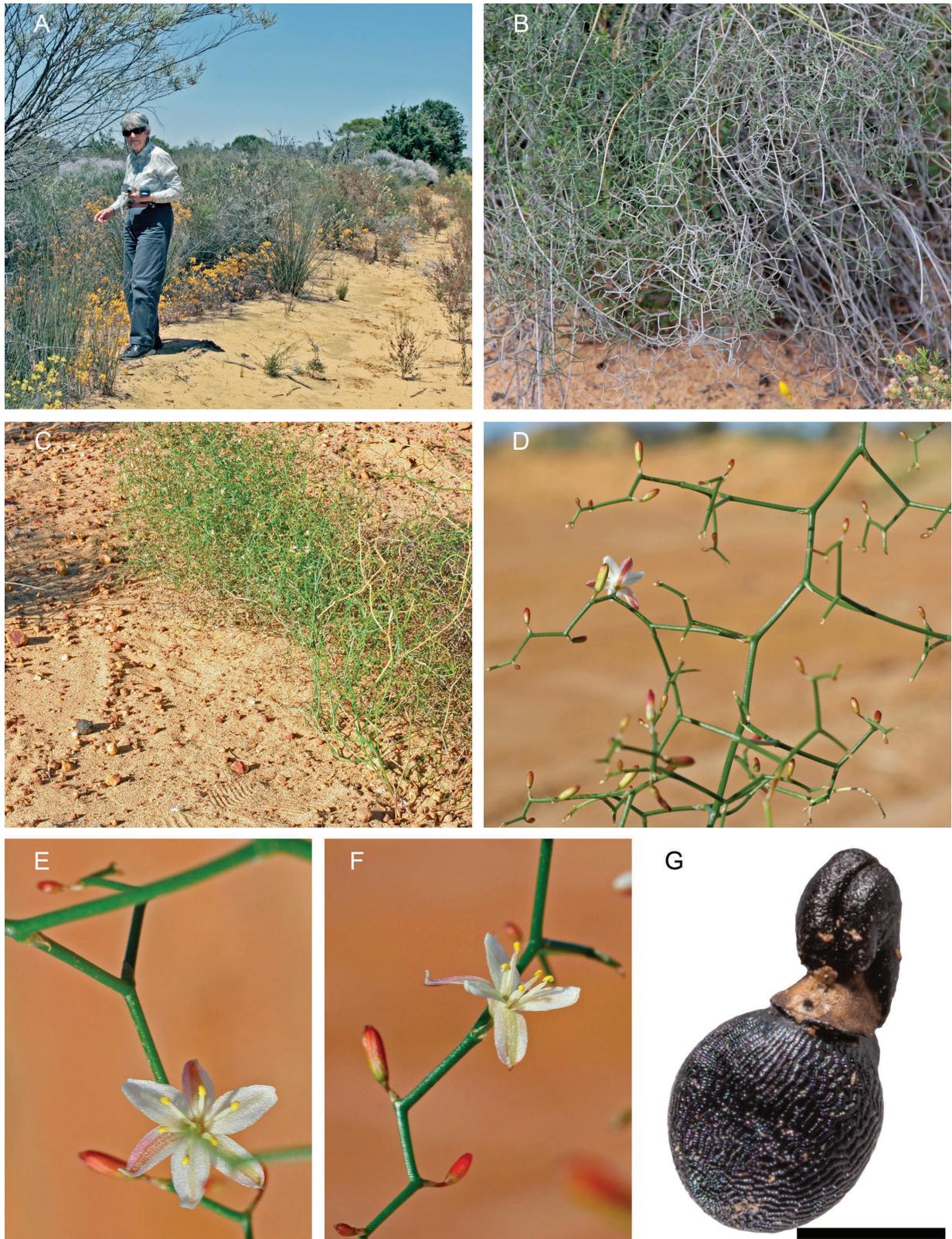
***Corynotheca dichotoma*** (F.Muell.) F.Muell. ex Benth., *Fl. Austral.* 7: 50 (1878); *Caesia dichotoma* F.Muell., *Fragm.* 1(9): 215 (1859).

Type: Mouth of the Murchison R., Western Australia, *n.d.*, *A.F. Oldfield s.n.* (lecto: MEL 107033), designated by R.J.F.Henderson, *Fl. Austral.* 45: 301 (1987), (as ‘holo’); N. [presumably Mouth] of the Murchison R., W.A., *A.F. Oldfield s.n.* (presumed isolecto: MEL 107035).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, 150–250 mm long, fleshy-fibrous, sand-binding. *Stems* short, to 35 mm long and 7 mm wide. *Leaves* few, linear-subulate, to 67 mm long, 0.8–1.5 mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, to 105 cm long, dark green; peduncle ascending to decumbent, subterranean at base; major branches decumbent; lowest branch 7–34 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 80–140°; racemules with axis tortuous, 15–60 mm long, with (1–)5–13 nodes, each node divaricate at 80–110°, but sometimes reduced to 1 internode c. 1.5 mm long, finely ribbed, but otherwise smooth; internodes 1–7 mm long, (0.2–)0.4–0.6 mm wide, ±straight; flowers solitary in branch axils, ?most developing; lower bracts linear-subulate, 7–17 mm long, acuminate; uppermost bracts obovate to ±triangular, 0.6–1.2 mm long; pedicels 0.8–2.3 mm long. *Perianth* 4.1–5.0 mm long, segments connate for c. 0.5 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly oblong, 2.9–4.5 mm long, 0.8–1.1 mm wide, apex apiculate, with a minute appendage c. 0.2 mm long, mostly white, median band grading to pink to purplish to brown, margins white. *Petals* narrowly oblong, 4.6–4.8 mm long, 0.9–1.0 mm wide, acute, white to cream, median band sometimes darker abaxially. *Filaments* widely spreading, straight or slightly incurving, 2.2–2.7 mm long, subequal, not or only slightly dilated, minutely papillose, white; anthers 0.7–0.9 mm long. *Style* filiform, to 3.7 mm long, exceeding stamens. *Capsule* antrorse, obpyriform, 2.9–3.4 mm long, c. 1.8 mm wide, brown, slightly wrinkled. *Seed* 1 per fruit, 2.9–3.3 mm long, c. 1.5 mm wide, glossy black to iridescent, longitudinally striate; caruncle conical distally, the lobes fused. *2n* = 42 (G.J. Keighery, *Feddes Repert.* 95: 527 (1984); Keighery 1789, as *C. ‘macrantha’*) (Figures 5b, 11).

**Diagnostic characters:** Racemule 15–60 mm long, with (1–)5–13 internodes, diverging at 80–110°, internodes 1–7 mm long, inflorescence dense, but not gnarled and perianth 4.1–5.0 mm long.

**Other specimens examined:** WESTERN AUSTRALIA: NW Coastal Highway, c. 42 km by road N of Murchison River crossing, 2 Sept. 1977, *W.R. Barker 2191* (AD, MEL, NSW); 9.3 km S on Moore Road from Geraldton–Mt Magnet Road, on E side of road, Indarra Nature Reserve, Western Australia, 20 Oct. 2008, *R.L. Barrett & B.G. Briggs RLB 5280* (CANB, K, MEL, NSW, PERTH); 13 miles W of Kalbarri turnoff from NW Coastal Highway, 5 miles NW of Mount View, S of Murchison River, 22 Aug. 1965, *A.C. Beauglehole ACB 11926* (PERTH); Emu Springs in Kalbarri National Park, 25 Nov. 1995, *D. & B. Bellairs 3010* (CANB); Balla, 13 Oct. 1964, *W.H. Butler s.n.* (PERTH); Wandana Reserve, 9 Oct. 2006, *G. Byrne 2430* (PERTH); 411 mile peg on Geraldton – Carnarvon road [6 km N of Billabong Roadhouse on North West Coastal Highway], 18 Mar. 1958, *S.G.M. Carr 444* (PERTH); S end Moore Road junction Eves Road, 25 Nov. 2001, *J. Docherty 82* (PERTH); Near Homestead, Dirk Hartog Island, 3 Sept. 1972, *A.S. George 11416* (PERTH); upper Irwin River, *J. Guerin s.n.* (MEL 107053); c. 12 km S of Billabong Roadhouse, 6 Aug. 1976, *R. Hnatiuk 760405* (PERTH); 10.5 km E of Kalbarri town, 19 Sept. 1974, *G.J. Keighery 1789* (PERTH); 8 km S along Indarra South Road, from Geraldton to Mullewa Road, 20 km S of Mullewa, 25 Oct. 1988, *G.J. Keighery 10922* (PERTH); Upper Irwin River, Nov. 1877, *O.L. Jones s.n.* (MEL 107045, MEL 107046, MEL 107047); c. 3 km SW of Trig Station Spit, Heirisson Prong, Shark Bay, West of Rubberneck Road, 26 Sept. 1997, *A. Markey 1478* (PERTH); Greenough River, Nov. 1877, *F.Mueller s.n.* (MEL 107040); lower Greenough River, Nov. 1877, *F.Mueller s.n.* (MEL 107041); E margin of Kalbarri National Park, 26 Nov. 1974, *R. Pullen 9647* (BRI, CANB, HO, *n.v.*, NSW, PERTH); between the Murchison and Irwin Rivers, *Miss Sewell s.n.* (MEL 107042); Waggrakine, at base of Moresby Range, 27 Oct. 1998, *S. Vigilante 5* (PERTH); Yandanogo Nature Reserve (NR 36203), 8.3 km E of Brand Highway on Mt Adams Road, 4 Nov. 2008, *V. Westcott S.M. 75 A* (PERTH); Quadrat WEST 2 on Eurardy Station, c. 43 km N of Kalbarri turn-off on the North West Coastal Highway and N of Murchison River, 3 Oct. 2003, *Wildflower Society of WA EURA 258* (PERTH).



**Fig. 11.** *Corynotheca dichotoma*. A. Habitat with Barbara Briggs, 2008. B, C. Habit. D. Flowering branches. E, F. Flowering branchlet. G. Seed. Vouchers: East Yuna Nature Reserve (A, B); Wandana Nature Reserve, G. Byrne 2430 (PERTH; C–F); and Indarra Nature Reserve, R.L. Barrett & B.G. Briggs RLB 5280 (PERTH; G). Scale = 1 mm. Photographs by R.L. Barrett (A, B, G) G. Byrne (C–F).

**Distribution:** Scattered in the Mid West region of southern Western Australia, from near Mullewa, north to Shark Bay and Dirk Hartog Island (Figure 8B).

**Habitat:** Grows on yellow sand flats and sand dunes, on deep sands or over clay or laterite. Associated species include *Acacia scirpifolia*, *A. rostellifera*, *Anthotroche myoporoides*, *Baeckea robusta*, *Banksia prionotes*, *B. sceptrum*, *Calothamnus glaber*, *Calytrix brevifolia*, *C. strigosa*, *Comesperma griffinii*, *Conostylis resinosa*, *Ecdeiocolea monostachya*, *Enchylaena tomentosa*, *E. rigens*, *Eucalyptus gittinsii*, *Grevillea annulifera*, *G. bracteosa*, *G. leucopteris*, *Hakea bucculenta*, *Harperia ferruginipes*, *Jacksonia velutina*, *Lachnostachys eriobotrya*, *Lepidobolus basiflorus*, *L. densus*, *L. eurardyensis*, *L. preissianus* subsp. *volubilis*, *Mesomelaena pseudostygia*, *M. stygia*, *Persoonia acicularis*, *P. biglandulosa*, *Petrophile pilostyla* subsp. *syntoma*, *Pileanthus peduncularis*, *Schoenus pennisetis*, *S. sp. Indarra* (R.L. Barrett & B.G. Briggs RLB 5277), *Scholtzia sp. Binnu* (M.E. Trudgen 2218), *Thryptomene hubbardii*, *Verreauxia reinwardtii* and *Xylomelum angustifolium*.

**Phenology:** Flowers mostly between August and November, or later in response to summer rainfall events. Only a single collection, made in March, is in fruit, suggesting that ideal conditions may be required for fruit set. Flowers are noted to usually open in the late afternoon.

**Conservation status:** *Corynotheca dichotoma* is known to occur in several National Parks and Nature Reserves and is not currently considered threatened.

**Common name:** Intricate Zigzag Lily.

**Etymology:** The epithet is from the Latin *dichotomos* (dividing in half), in reference to the regular divergence of the stems of this species.

**Affinities:** *Corynotheca dichotoma* appears most similar to *C. flexuosissima* R.J.F.Hend. based on the compact inflorescence with smooth axes, but is also superficially similar to *C. asperata* R.J.F.Hend. in inflorescence branching pattern, but that species is very distinctive in having finely scabrid (*vs* glabrous) stems, fibrous (*vs* fleshy-fibrous) roots and racemules with (0)1–6 (*vs* (1–)5–13) nodes. *Corynotheca dichotoma* can be readily distinguished from *C. flexuosissima* by the more openly branching racemules 15–60 (*vs* 4–12(–25)) mm long, with (1–)5–13 (*vs* (5–)9–20) nodes, internodes 1–7 (*vs* 0.8–2) mm long, longer peduncles 0.8–2.3 (*vs* 0.2–0.9) mm long and larger perianth 4.1–5.0 (*vs* 1.4–2.1) mm long.

**Notes:** Henderson (1987) commented under his *C. micrantha* var. *micrantha* that “Field studies may show material included here represents more than one taxon” and one of the cited specimens (Pullen 9647) is here included under *C. dichotoma* following examination of this species in the field.

While Mueller (1870: 68) suggested that *Caesia dichotoma* might be best placed in *Corynotheca*, the combination was only validated by Bentham (1878: 50). Henderson (1987) designated a single collection at MEL as ‘holo’, however two collections are held at MEL, with differing label information, so Henderson’s designation is here corrected to an effective lectotypification. The label of the second specimen has generally been interpreted as ‘N.’ [North], but is probably ‘M.’ [Mouth], in which case it is most likely a duplicate of the lectotype.

***Corynotheca divaricata*** (R.J.F.Hend.) R.L.Barrett & T.Macfarlane, *comb. et. stat. nov.*

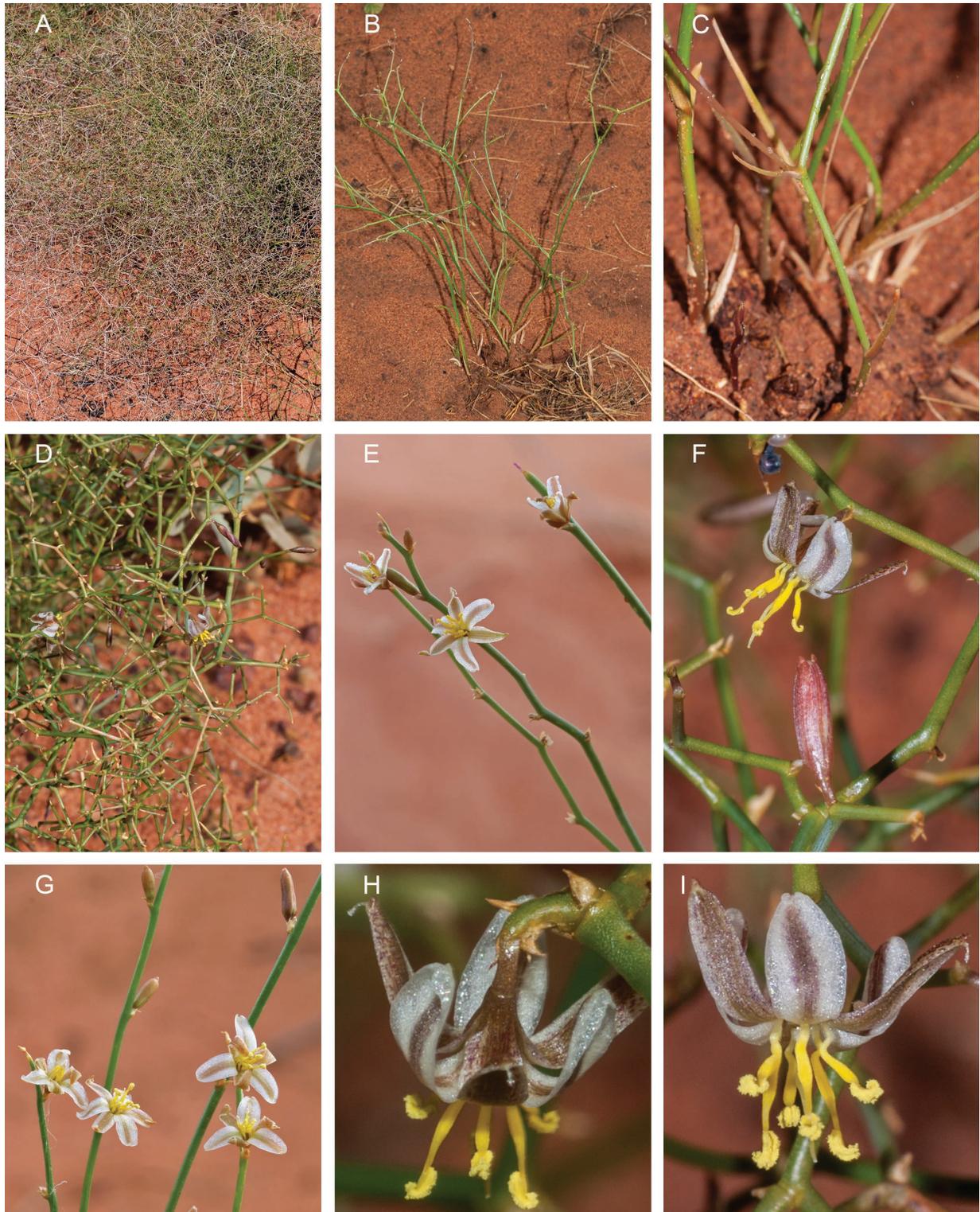
Basionym: *Corynotheca micrantha* var. *divaricata* R.J.F.Hend., *Fl. Austral.* 45: 474, 303, fig. 70i (1987).

Type: Cordillo Downs, c. 40 km W and c. 8 km S of Qld border, South Australia, 19 October 1963, *anon. ex Pastoral Board s.n.* (holo: AD 97916036\*).

*Corynotheca lateriflora* *auct. non* (R.Br.) F.Muell. ex Benth.: Jessop, J.P. in Jessop, J.P. & Toelken, H.R. (ed.) *Fl. S. Austral.* Edn. 4, 4: 1752 (1986), *p.p.*

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, 50–180 mm long, fleshy-fibrous, sand-binding. *Stems* short, to 20 mm long and 5 mm wide. *Leaves* few, linear-subulate, 14–68 mm long, 1.6–2.9 mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, uninterrupted, evenly diffuse, irregularly paniculate, to 60(–80) cm long, dark green; peduncle ascending to decumbent, subterranean at base; major branches spreading to decumbent; lowest branch 9–29 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 90–140°; racemules with axis tortuous, 17–95(–180) mm long, with 5–8(–10) nodes, each node diverging at 140–180°, finely ribbed, but otherwise smooth; internodes 4–13 mm long,  $\pm$ straight, 0.4–0.9 mm wide; flowers solitary or commonly paired (sometimes in threes) in branch axils, most developing; lower bracts linear-subulate, 6–38 mm long, acuminate; uppermost bracts obovate to  $\pm$ triangular or subulate, 1.2–7.1 mm long; pedicels 0.3–1.2(–2) mm long. *Perianth* 4.1–5.9 mm long, segments connate for c. 0.8 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly oblong, 2.9–5.1 mm long, 0.8–1.0 mm wide, apex apiculate, with a minute appendage c. 0.5 mm long, brown abaxially, margins white to mauve to pink adaxially, median band brown adaxially. *Petals* narrowly oblong, 2.8–5.0 mm long, 0.7–1.1 mm wide, acute, white to cream to mauve, median band brown. *Filaments* slightly spreading, often kinked at the base, sometimes straight or slightly incurving, 1.4–1.8 mm long, unequal, dilated and minutely papillose, yellow; anthers 0.6–0.7 mm long. *Style* filiform, to 1.7 mm

long, shortly exceeding stamens. *Capsule* erect to pendulous, obpyriform, 4.9–7.2 mm long, 1.3–1.9 mm wide, brown, slightly wrinkled. *Seeds* 1 or 2(3) per fruit, 2.3–3.7 mm long, 1.2–1.5 mm wide, very glossy black to iridescent, smooth to very finely pitted; caruncle conical distally, the lobes fused.  $2n = 42$  (G.J. Keighery, *Feddes Rept.* 95: 527 (1984); Keighery 563, as *C. lateriflora*) (Figures 2, 12).



**Fig. 12.** *Corynotheca divaricata*. A. Habit. B. Plant resprouting after fire. C. Plant base. D. Flowering branches. E. Racemules. F. Flower and developing fruit. G, H. Flowers. I. Seed. Vouchers: A, D, F, G: Shay Gap, R.L. Barrett RLB 8238 (PERTH); B, C: Browns Range, WA (not vouchered); E: near Kuta Jutta, D.E. Albrecht 12942 (NT) and F: Waite Creek, N. Henry 365 (NSW). Scale = 1 mm. Photographs by R.L. Barrett (A–D, F–I) and D.E. Albrecht (E).

**Diagnostic characters:** Basal leaves 1.6–2.9 mm wide, racemules 17–95(–180) mm long, with 5–8(–10) nodes, internodes 4–13 mm long, pedicels 0.3–1.2 mm long, perianth 4.1–5.9 mm long, seed testa smooth to very finely pitted.

**Selected specimens examined:** WESTERN AUSTRALIA: 1.4 km S on Boreline Road from Great Northern Highway, E of Pardoo Roadhouse, Dampier Botanical District, 26 July 2013, *R.L. Barrett RLB 8238* (PERTH); Gibson Desert, Gibber Plains area, 90 km SW of Lake Christopher, 9 May 1980, *J.M. Bechervaise & J. Kelso 7* (MEL); 50 miles NE of Cosmo Newberry Mission, 28 Sept. 1966, *A.S. George 8116* (PERTH); beyond the Alfred Maries Range, *W.E.P. Giles s.n.* (MEL 107038); near Sally May well site, Great Sandy Desert, 28 June 2009, *G.F. Griffin & S.R. Dunlop GSD 09-117* (PERTH); Barrow Range, 19 Aug. 1891, *R. Helms s.n.* (MEL 107039); Little Sandy Desert, northern edge of Lake Sunshine, 19 Aug. 2001, *S. van Leeuwen 4993* (AD, *n.v.*, CANB, PERTH). NORTHERN TERRITORY: 20 km NNW of Finke Settlement, 10 Nov. 1993, *D.E. Albrecht 5640* (BRI, DNA, *n.v.*, MEL, NSW, NT, *n.v.*); c. 17 km NW of Mt Campbell, 6 May 1958, *G. Chippendale 4312* (AD, *n.v.*, BRI, CANB, DNA, *n.v.*, MEL, NSW, PERTH); SE corner of Lake Amadeus, Central Australia, 29 June 1959, *G. Chippendale 6369* (AD, *n.v.*, CANB, DNA, *n.v.*, MEL, NSW, PERTH); Lake Mackay, on island on SE edge of lake, 10 Oct. 1992, *P.K. Latz 12868* (DNA, *n.v.*, K, *n.v.*, MEL, MO, *n.v.*, NSW, NT, *n.v.*), South Tobermorey Station, Simpson Desert, 25 Oct. 2001, *P.K. Latz 18195* (BRI, NT, *n.v.*); Uluru (Ayers Rock - Mt Olga) National Park: on the Docker River Road, 17 May 1988, *M. Lazarides & J. Palmer 179* (AD, *n.v.*, CANB, DNA, *n.v.*). SOUTH AUSTRALIA: Mokari, Simpson, 27 Aug. 1977, *R. Buckley 1712* (ANU 26612) (CANB); c. 7 km ESE of Marqualpie Waterhole, 12 May 1987, *R.W. Purdie 2923A* (AD, *n.v.*, CBG); Far North, in from W edge of Simpson Desert, 78.4 km, via Purnie and Mokari Bores, 28 Sept. 1974, *D.E. Symon 9443* (AD, *n.v.*, CANB, DNA, *n.v.*). QUEENSLAND: 37 km SE of Springvale, 30 Sept. 1982, *R.J. Chinnock 5567* (AD, CBG); SW corner of Pilpah Range, 12.5 km NNE of Barkly Downs homestead, 10 Nov. 2004, *D.T. Kelman DTK 101104-9 & C. Kahler* (BRI); Warlus VI, Site R56 (24 km SE of Betoota), 18 Sept. 1977, *R.W. Purdie 1144* (BRI); 8 km S of Mooraberrie Station, 6 Nov. 1978, *R.W. Purdie 1151* (CBG); Farriers Creek, Morney Plains Station, 9 Sept. 2011, *D. Richter DR 271 & G.P. Turpin* (BRI).

**Distribution:** A widespread species in inland Australia, from near Wiluna north to Shay Gap and the Tanami Desert in Western Australia, through central Northern Territory and the north of South Australia to Springvale in south east Queensland (Figure 8A).

**Habitat:** Grows on sand dunes and sandy ridges in low, open shrubland with *Acacia hilliana*, *A. monticola*, *A. tumida*, *Allocasuarina decaisneana*, *Aristida holathera*, *Calandrinia eremaea*, *Corymbia zygophylla*, *Crotalaria cunninghamii*, *C. eremaea*, *Eragrostis basedowii*, *Goodenia scaevolina*, *Grevillea juncifolia*, *G. stenobotrya*, *Gyrostemon ramulosus*, *Halgania solanacea*, *Heliotropium transforme*, *Lechenaultia divaricata*, *Newcastelia cladotricha*, *Polymeria lanata*, *Ptilotus axillaris*, *P. incanus*, *Solanum centrale*, *S. diversiflorum*, *S. phlomoides*, *Trachymene oleracea*, *Triodia basedowii*, *T. pungens* and *Zygochloa paradoxa*.

**Phenology:** Flowers mainly (July–)August–December, but also recorded for March–April.

**Conservation status:** *Corynotheca divaricata* is widespread and is not currently considered threatened.

**Common names:** Desert Zigzag Lily, Sand Lily.

**Etymology:** The specific epithet is from the Latin *divaricatus* (widely spreading), in reference to the divaricate, ±straight racemules and inflorescence axes.

**Affinities:** *Corynotheca divaricata* may be most closely related to *C. asperata*, sharing a robust habit and arid habitats, differing in the glabrous (*vs* scabrous) inflorescence axes, racemules with 5–8(–10) (*vs* (0)1–6) nodes, 17–95 (*vs* 4–23(–50)) mm long. Sometimes confused with *C. licrota* which has an erect (*vs* spreading) habit, fibrous (*vs* fleshy-fibrous) roots, persistent (*vs* dry at anthesis) leaves 50–300(–600) (*vs* 14–68) mm long and striate (*vs* smooth to finely pitted) seeds with free (*vs* fused) caruncle lobes.

Probably not closely related to *C. micrantha s. str.*, which differs in having narrower leaves 0.6–1.6 (*vs* 1.6–2.9) mm wide, shorter racemules 12–40 (*vs* 17–95) mm long with fewer (2–4 *vs* 5–8(–10)) nodes, solitary (*vs* usually paired) flowers, longer pedicels 1.2–2.9 (*vs* 0.3–1.2) mm long, smaller perianths 2.8–4.5 (*vs* 4.5–5.9) mm long, white, erect (*vs* yellow, spreading) staminal filaments and striate seeds (*vs* smooth to finely pitted).

*Corynotheca gracilis* overlaps in distribution in north-western Australia, but is readily distinguished from *C. divaricata* by the fibrous (*vs* fleshy-fibrous) roots, basal leaves 7–15(–20) (*vs* 14–68) mm long, 0.5–0.8(–1.1) (*vs* 1.6–2.9) mm wide, racemules with 5–8(–10) (*vs* 2–5) nodes, 0.2–0.4 (*vs* 0.4–0.9) mm diam., flowers usually solitary (*vs* usually paired), pedicels 1.0–3.1 (*vs* 0.3–1.2) mm long, seeds 3.4–4.7 (*vs* 2.3–3.7) mm long and striate (*vs* smooth to very finely pitted).

**Notes:** Previous records for New South Wales were based on misidentifications, including of sterile *Lechenaultia divaricata* F.Muell. Specimens of *C. divaricata* are known from adjacent parts of South Australia, so it may yet be located in far NE New South Wales.

Henderson (1987) noted that *G. Chippendale 4312* might represent a discrete taxon. While the racemules are  $\pm$ straight in this collection, numerous similar collections are now available and this character is variable, even within individual specimens, so no taxonomic distinction is recognised here, but further field studies may be justified (P. Jobson & D. Albrecht, pers. comm.). Both variants are illustrated in Fig. 2. A variant with striate seeds from central Northern Territory (*D.E. Albrecht 12759* & *P.K. Latz*; *D.E. Albrecht 13285* & *P.K. Latz*; NT), has not been directly examined (images seen), but may represent a discrete taxon. It is recognised as *Corynotheca micrantha* var. *ridged seeds* (*D.E. Albrecht 12759* & *P.K. Latz*) by the Northern Territory Herbarium.

***Corynotheca elongata*** (R.J.F.Hend.) R.L.Barrett & T.Macfarlane, *comb. et. stat. nov.*

Basionym: *Corynotheca micrantha* var. *elongata* R.J.F.Hend., *Fl. Austral.* 45: 475, 303, fig. 70h (1987).

Type: St Fergus road, between Toodyay Rd and Avon R., Western Australia, 4 Jan. 1972, *N.T. Burbidge 8012* (holo: PERTH 01115731; iso: CANB 210426, CANB 210427, MEL 222040).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, at least 50 mm long, fleshy-fibrous, sand-binding. *Stems* not seen. *Leaves* few, linear-subulate, 5–34 mm long, 0.8–1.7 mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, uninterrupted, evenly or somewhat unevenly diffuse, irregularly paniculate, to 60 cm long, dark green; peduncle ascending to decumbent, subterranean at base; major branches outwardly curved to decumbent; lowest branch at least 10 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 90–150°; racemules with axis subtortuous, 37–78(–200) mm long, with 4–8 nodes, each node diverging at (160–)170–180°, finely ribbed, but otherwise smooth or crenulate; internodes 4–13(–20) mm long,  $\pm$ straight to curved, 0.2–0.5 mm wide; flowers solitary in branch axils, most developing; lower bracts linear-subulate, 3.5–7 mm long, acuminate; uppermost bracts obovate to  $\pm$ triangular, 0.5–1.6 mm long; pedicels 0.8–1.9(?–3) mm long. *Perianth* 3.1–4.3 mm long, segments connate for *c.* 0.5 mm, spirally twisting after anthesis, deciduous. *Sepals* ovate, 2.8–4.0 mm long, 1.0–1.3 mm wide, apex apiculate, with a minute appendage *c.* 0.2 mm long, pink to purplish to brown, mostly white adaxially, median band darker abaxially. *Petals* ovate, 2.6–3.5 mm long, 1.0–1.2 mm wide, acute, white to cream, median band greenish. *Filaments* held erect, straight or slightly incurving, 1.8–2.5 mm long, subequal, dilated and minutely papillose, white; anthers 0.5–0.6 mm long. *Style* filiform, to 2.1 mm long, *c.* equalling stamens. *Capsule* erect to pendulous, obpyriform, 3.1–4.2 mm long, 1.8–2.2 mm wide, brown, slightly wrinkled. *Seeds* 1 or 2 per fruit, 1.8–2.7 mm long, *c.* 1.4 mm wide, glossy black to iridescent, longitudinally striate; caruncle conical distally, the lobes fused (Figure 13).

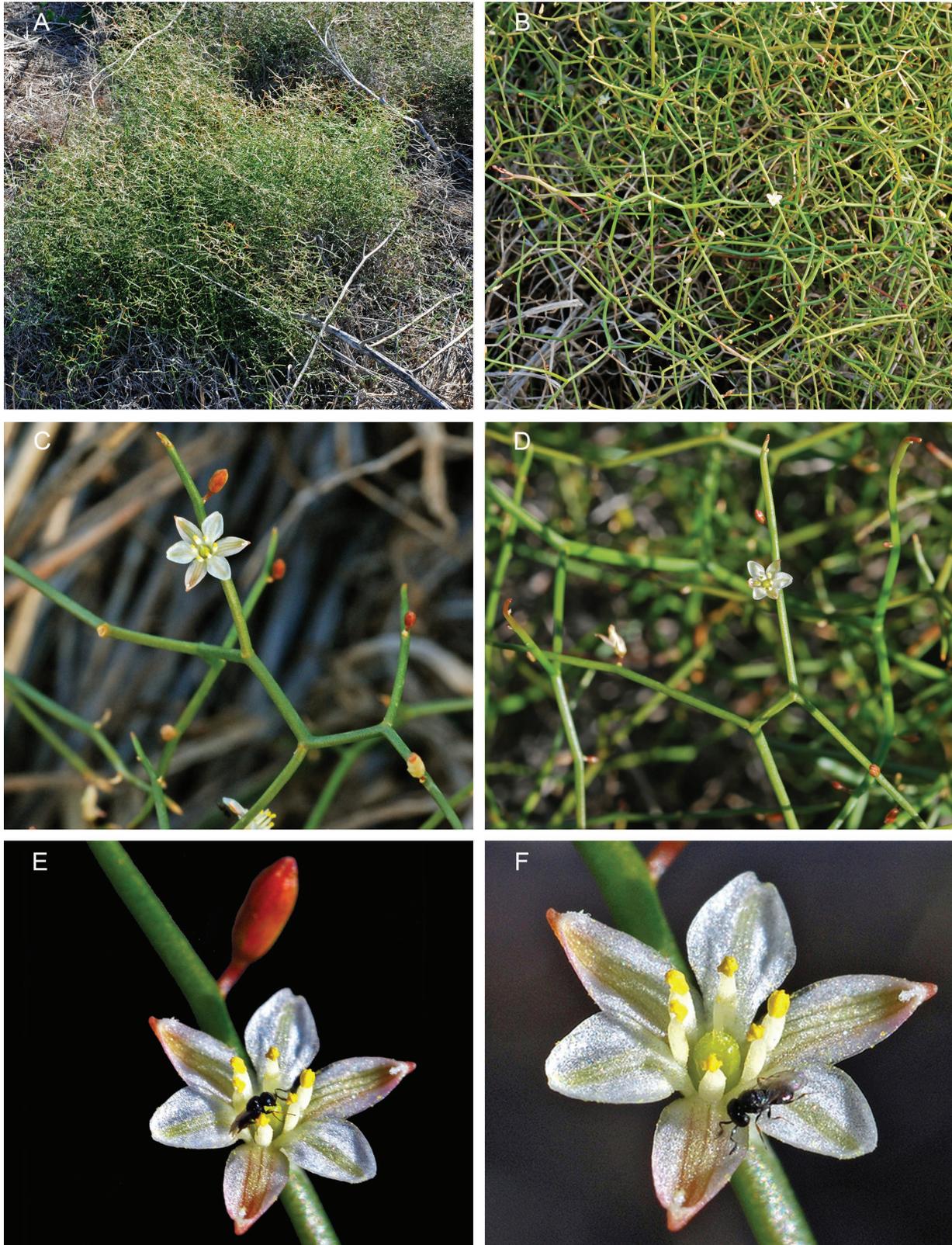
**Diagnostic characters:** Basal leaves 5–34 mm long; racemules with 4–8 internodes, diverging or straight ((160–)170–180°), internodes 4–13(–20) mm long, 0.2–0.5 mm diam.,  $\pm$ straight; seeds 1.8–2.7 mm long.

**Selected specimens examined:** WESTERN AUSTRALIA: Ridley Road, 1.2 km SW Mount Billy, 13 Nov. 1996, *M.G. Allen 941* (PERTH); between Perth and York, Nov. 1877, *F. Mueller s.n.* (MEL 107037); Preston and Collie Rivers, 7 Dec. 1877, *F. Mueller s.n.* (MEL 107272); Landsell remnant bushland Popanyinning, 13 Nov. 1996, *A.G. Gunness et al., POPO 15/61* (PERTH); Yanchep National Park: 0.5 mile up track on W side of Loch, 18 Nov. 1963, *A. James 127* (PERTH); Moore River Bridge at junction Lancelin-Gingin road, 30 Nov. 1974, *T.A. Halliday 179* (AK, *n.v.*, CANB, PERTH); Hi Vallee property (D. & J. Williams) Warradarge, close to creekline near E boundary of property, 7 Dec. 2002, *M. Hislop 2904* (PERTH); Greenhills Railway embankment, W of Lott Road, S side Jamieson's land, 16 Jan. 2000, *C. Howell CH 481* (PERTH); 19 km NW Williams to Arthur River, 26 Nov. 1984, *G.J. Keighery 7412* (CANB, PERTH); Wilgie Creek Reserve No. 40339, North Yunderup, 26 Oct. 2000, *P. Payne 11* (PERTH); Reserve A21064 located *c.* 15 km directly NE of Arthur River townsite, 24 Nov. 1998, *L. W. Sage* & *F. Obbens LWS 1414* (PERTH); Helena Valley, 27 Jan. 2000, *J. Seabrook 517* (CANB); Lake Ronnerup, *c.* 19 km SSW of Lake King townsite, 22 Sept. 2001, *A. Webb* & *B. Muir 606* (PERTH).

**Distribution:** From Eneabba south to Dunsborough, inland to near Arthur River and disjunct populations at Lake Coomelberrup 10 km SSE of Dumbleyung, Jilakin Rock, and near Lake King in Western Australia (Fig. 7).

**Habitat:** Grows on white, grey or yellow sand, often in heath (kwongkan) with *Alexgeorgea nitens*, *Banksia nobilis* subsp. *fragrans*, *B. stenoprion*, *B. tortifolia*, *Calothamnus sanguineus*, *Corymbia calophylla*, *Ecdeiocolea monostachya*, *Eucalyptus accedens*, *E. camaldulensis*, *E. rudis*, *Macrozamia fraseri*, *Melaleuca urceolaris*, *Nuytsia floribunda*, *Schoenus griffinianus*, *Thryptomene hyporhytis*, *Verticordia eriocephala*, *V. grandis* and *V. ovalifolia*.

**Phenology:** Flowers mostly in November–January.



**Fig. 13.** *Corynotheca elongata*. A. Habit. B. Flowering branches. C, D. Flowering branchlets. E, F. Flowers. Images from Calingiri (not vouchered). Photographs by F. & J. Hort.

**Conservation status:** *Corynotheca elongata* is widespread and is not currently considered threatened, though numerous roadside populations have been noted to be in decline, especially at the northern end of the species' range (J. Hort, pers. comm.).

**Common name:** Spreading Sand Lily.

**Etymology:** The specific epithet is from the Latin *elongatus* (lengthened, elongated), in reference to the elongated  $\pm$ straight racemules.

**Affinities:** *Corynotheca elongata* is probably most closely related to *C. panda*, differing in the basal leaves 5–34 (vs 45–180) mm long, racemules diverging or straight (160–)170–180° (vs diverging at 140–180°), 0.2–0.5 (vs 0.3–0.7) mm diam.,  $\pm$ straight (vs  $\pm$ straight to evenly curving) and seeds 1.8–2.7 (vs 2.8–3.3) mm long. Possibly also related to *C. pungens*, which has persistent cauline leaves and pungent bracts.

**Notes:** Henderson (1987) thought that this taxon may merge with *C. panda*, and their geographical ranges do approach each other, but morphological intergradation has not been observed, and their ranges do not actually overlap. The inland populations may warrant further field-based study to assess variation in these isolated populations.

*Corynotheca flexuosissima* R.J.F.Hend., *Fl. Austral.* 45: 474, 304, figs 70j, 96f, g (1987).

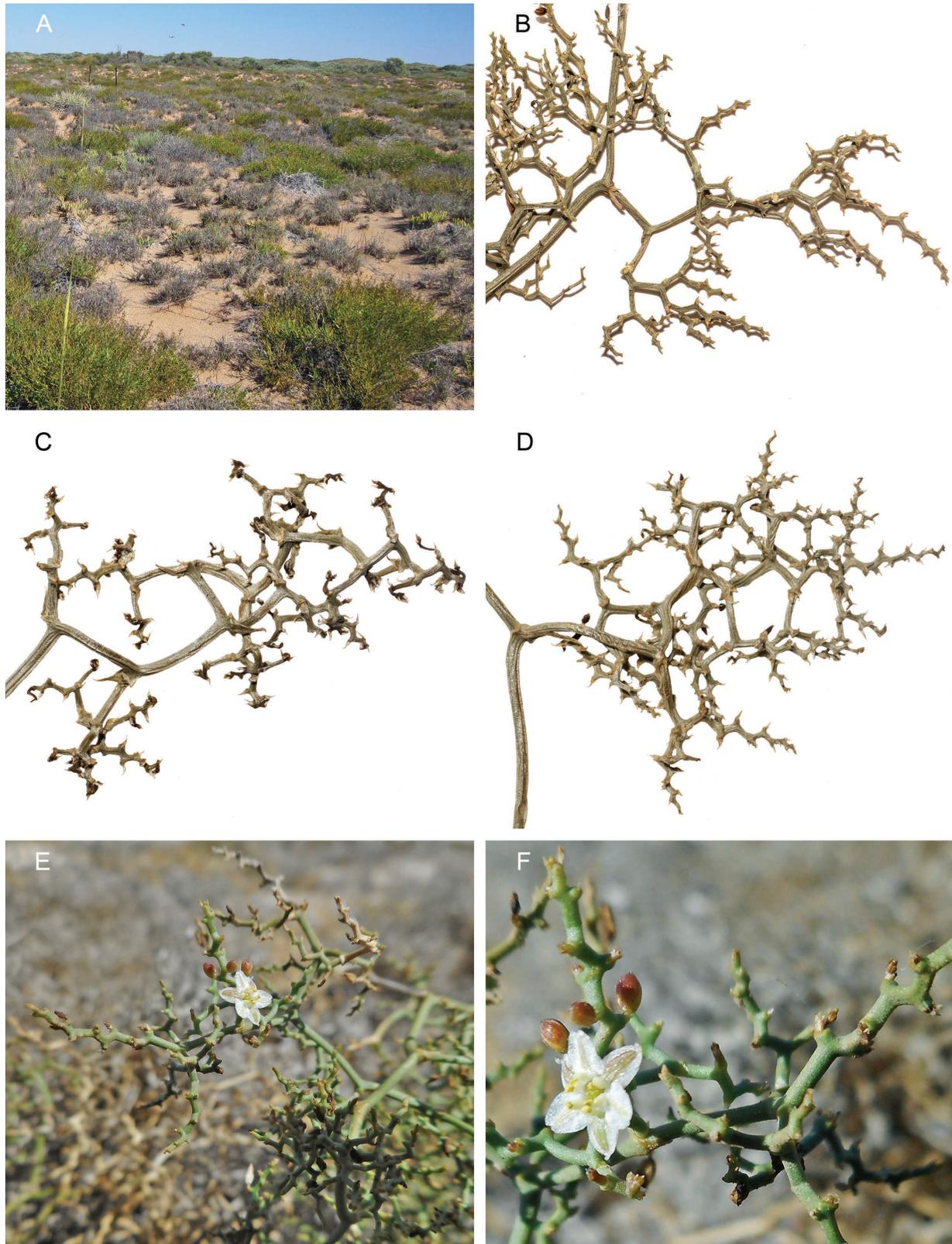
Type: Barrow Is., Western Australia, Oct. 1980, *R. Buckley* 7222 (holo: PERTH 115308).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* few, deeply buried, at least 50 mm long, fleshy-fibrous, sand-binding. *Stems* not seen. *Leaves* few, linear-subulate, 12–23 mm long, 0.6–1.1 mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, to 60 cm long, light dull green; peduncle ascending to decumbent, long-subterranean at base; major branches decumbent; lowest branch 4–30 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 80–150°; racemules with axis tortuous, 4–12(–25) mm long, with (5–)9–20 nodes, each node divaricate at 90–150°, finely ribbed, but otherwise smooth; internodes 0.8–2 mm long, 0.2–0.6 mm wide, straight to gently curving; flowers solitary in branch axils; lower bracts linear-subulate, 5–13 mm long, acuminate; uppermost bracts obovate to  $\pm$ triangular, 0.3–1.2 mm long; pedicels 0.2–0.9 mm long. *Perianth* 1.4–2.5 mm long, segments connate for *c.* 0.2 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly ovate to elliptic, 1.3–2.2 mm long, 0.7–0.8 mm wide, apex apiculate, with a minute appendage *c.* 0.1 mm long, margins white, median band greenish to pale brown darker. *Petals* elliptic, 1.2–2.4 mm long, 0.7–0.8 mm wide, acute, white to cream, median band sometimes greenish. *Filaments* held erect, straight or slightly incurving, subequal, 0.6–0.8 mm long, white, minutely papillose; anthers *c.* 0.3 mm long. *Style* filiform, to 0.9 mm long, exceeding stamens. *Capsule* antrorse, ovoid to obovoid, 2.5–3.0 mm long, 1.2–1.7 mm wide, brown, slightly wrinkled. *Seed* 1(2) per fruit, 1.8–2.1 mm long, *c.* 1.3 mm wide, glossy black to iridescent, longitudinally striate; caruncle conical distally, the lobes fused. *2n* = 42 (G.J. Keighery, *Feddes Repert.* 95: 527 (1984); Wittwer 1783, as *C. acanthoclada*). (Figures 3a, 14)

**Diagnostic characters:** Plants with leaves all basal, dry at anthesis, reduced to bracts above, upper bract apices acuminate, but not pungent, inflorescence with a dense, gnarled appearance, racemules 4–12(–25) mm long, 0.2–0.6 mm diam., with (5–)9–20 nodes, internodes 0.8–2 mm long, perianth 1.4–2.1 mm long.

**Other specimens examined:** WESTERN AUSTRALIA: Barrow Island, Oct. 1980, *R. Buckley* 7202 (PERTH); Thevenard Island, N side 1 km from W end, 30 June 1988, *H. Butler & V. Long* VL 275 (PERTH); Thevenard Island, 15 May 1954, *W.H. Butler* 10899/63 (PERTH); NW Cape, near Lighthouse, 1 Jan. 1961, *A.S. George* 2302 (PERTH); Vlaming Head, E of lighthouse, 24 May 1965, *A.S. George* 6587 (PERTH); 4–5 miles N of Yardie Creek, 27 May 1965, *A.S. George* 6657 (PERTH); *c.* 6 miles N of Yardie Creek, W of Cape Range, 6 Sept. 1970, *A.S. George* 10309 (CANB, MEL, PERTH); Long Island [Serrurier Island], Onslow, 31 July 1963, *D.W. Goodall* 584 (PERTH); Cape Range Peninsula, W coastal area, 1 Oct. 1995, *S. Hunger & N. Kilian* 4175 (PERTH); Cape Range Peninsula, North West Cape, coastal area, 2 Oct. 1995, *S. Hunger & N. Kilian* 4181 (PERTH); Boodie Island, off southern tip of Barrow Island, Pilbara Coast, 26 Oct. 2000, *K.F. Kenneally* 11628 (CANB, PERTH); Long Island, NW of Onslow [Serrurier Island], 23 May 1960, *R.D. Royce* 6337 (PERTH); Thevenard Island, NW of Onslow, 24 May 1960, *R.D. Royce* 6357 (PERTH); 60 m S of navigation tower at W end of [Thevenard] Island, 23 May 1990, *M. White* MRW 037 (PERTH); Vlaming Head, 9 Aug. 1976, *E. Wittwer* W 1783 (PERTH).

**Distribution:** Restricted to a small area from Cape Range to Onslow on the mainland, and a few offshore islands north to Boodie and Barrow Islands in Western Australia (Figure 8A).



**Fig. 14.** *Corynotheca flexuosissima*. A. Habitat on Serrurier Island. B. Flowering branches. C–E. Racemules. F. Flower. Images from Serrurier Island (not vouchered) (A, E, F); Voucher: Boodie Island, *K.F. Kenneally 11628* (CANB) (B–D). Photographs by V. Long (A, E, F); R.L. Barrett (B–D).

**Habitat:** Grows on beach sand and coastal limestone in stunted grassland and open low shrubland with *Acacia ampliceps*, *A. bivenosa*, *A. sclerosperma*, *Amaranthus undulatus*, *Arivela viscosa*, *Boerhavia coccinea*, *Commicarpus australis*, *Cynanchum viminalis* subsp. *australe*, *Enneapogon caeruleus*, *Eragrostis falcata*, *Eulalia aurea*, *Euphorbia trigonosperma*, *Salsola australis*, *Scaevola cunninghamii*, *S. spinescens*, *Spinifex longifolius* and *Triodia* spp.

**Phenology:** Flowers mostly May–July(–October).

**Conservation status:** Restricted in distribution in a region with several active developments, *Corynotheca flexuosissima* is recommended for listing as a Priority 4 taxon in Western Australia and assessment of population sizes should be undertaken to determine long-term risks to this species.

**Common name:** Compact Zigzag Lily.

**Etymology:** The specific epithet is from the Latin *flexuosus* (flexuose, zigzag) and the termination *-issimus* (extremely, remarkably), in reference to the compact, zigzag racemule axes.

**Affinities:** *Corynotheca flexuosissima* is most likely to be confused with *C. asperata* and *C. dichotoma* based on the compact inflorescence of each species. *Corynotheca asperata* is very distinctive in having finely scabrid (*vs* glabrous) stems, fibrous (*vs* fleshy-fibrous) roots and racemules with (0)1–6 (*vs* (5–)9–20) nodes. *Corynotheca dichotoma* can be readily distinguished from *C. flexuosissima* by the more openly branching racemules 15–60 (*vs* 4–12(–25)) mm long, with (1–)5–13 (*vs* (5–)9–20) nodes, internodes 1–7 (*vs* 0.8–2) mm long, longer peduncles 0.8–2.3 (*vs* 0.2–0.9) mm long and larger perianth 4.1–5.0 (*vs* 1.4–2.5) mm long.

**Notes:** It is interesting to note that most known populations are on islands, or in rocky environments on the Cape Range, and it may be fire sensitive, or very specific to coastal limestone soils.

***Corynotheca gracilis*** (R.J.F.Hend.) R.L.Barrett & T.Macfarlane, *comb. et stat. nov.*

Basionym: *Corynotheca micrantha* var. *gracilis* R.J.F.Hend., *Fl. Austral.* 45: 475, 302–303, fig. 96c–e (1987).

Type: behind Riddle Beach, 5 km SW of Broome townsite, S Kimberley, Western Australia, 17 June 1984, K.F. Kenneally 9025 (holo: PERTH 1115715; iso: BRI AQ0433514, CANB 379419).

Illustrations: Rye (1992; fig. 299f); Kenneally *et al.* (1996; pl. p. 200).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, 50–150 mm long, to 2.0 mm thick, fibrous, sand-binding. *Stems* short, to 10 mm long and 6 mm wide. *Leaves* few, linear-subulate, 7–15(–20) mm long, to 0.8(–1.1) mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, 30–150 cm long, dark green; peduncle ascending (sometimes decumbent at length), subterranean at base; major branches erect to ascending; lowest branch 1.5–8 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 90–150°; racemules with axis not or slightly tortuous, 20–60 mm long, with 2–5 nodes, each node divaricate at 110–140°; finely ribbed, but otherwise smooth; internodes 5–23 mm long, 0.2–0.4 mm wide,  $\pm$ straight; flowers solitary in branch axils, few–most developing; lower bracts  $\pm$ triangular, 5–12 mm long; uppermost bracts  $\pm$ triangular, 0.9–1.3 mm long, acuminate; pedicels 1.0–3.1 mm long. *Perianth* 4.0–6.5 mm long, segments connate for *c.* 0.5 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly elliptic to narrowly oblong-elliptic, 2.7–6.1 mm long, 1.1–1.4 mm wide, apex apiculate, with a minute appendage *c.* 0.15 mm long, margins white, median band brown. *Petals* narrowly oblong to narrowly elliptic, 4.0–5.8 mm long, 1.4–1.5 mm wide, obtuse, white to cream, median band cream to brown, slender. *Filaments* slightly spreading, straight or slightly incurving, 1.9–4.0 mm long, unequal, dilated and minutely papillose in lower 1/2 to 3/4, yellow; anthers 0.6–0.7 mm long. *Style* filiform, to 4.4 mm long, subequal to or exceeding stamens. *Capsule* antrorse, fusiform to obpyriform to obovate, 5.5–9.5 mm long, 2.5–3 mm wide, brown, slightly wrinkled. *Seed* 1(2) per fruit, 3.4–4.7 mm long, *c.* 1.8 mm wide, glossy black to brown, longitudinally striate; caruncle conical distally, blackish, the lobes fused (Figures 4c, 15).

**Diagnostic characters:** Basal leaves 7–15(–20) mm long, racemule internodes diverging at 80–100°, 0.2–0.4 mm wide, pedicels 0.9–1.3 mm long, perianth 4.0–6.5 mm long, staminal filaments 1.4–2.1 mm long, seeds 3.4–4.7 mm long.



**Fig. 15.** *Corynotheca gracilis*. A. Habit. B, C. Flowering branchlet. D–G. Flowers. H. Fruit; I. Seed. Vouchers: A–C, E: Roebuck Bay, Broome (not vouchered); D, F–H: north of Ngumban Cliffs, M.D. Barrett, R.L. Barrett & B. Anderson MDB 4193 (PERTH); and I: Broome, P.R. Foulkes 46 (PERTH). Scale = 1 mm. Photographs by R.L. Barrett.

**Selected specimens examined:** WESTERN AUSTRALIA: 45 km W of Sandfire Roadhouse on [Great Northern] Highway, 3 Sept. 1993, C.R. Alcock 11392 (AD, PERTH); c. 3 km SE of Ngumban Cliffs, 5 Apr. 2013, M.D. Barrett, R.L. Barrett & B. Anderson MDB 4193 (PERTH); Gary Junction Road, 77.7 km W of Kiwirrkura, 15 Sept. 2015, R. Butcher et al. RB 2081 (CANB, DNA, PERTH); Beagle Bay [Cape Leveque] Road, 10.5 km N of Great Northern Highway, 31 July 1974, G.W. Carr 4399 & A.C. Beaulehole 48177 (CANB, PERTH); ‘Robert’, northern Great Sandy Desert, 31 Aug. 2001, C.P. Campbell 3721 (PERTH); 25 km N of Broome, Dampier Peninsula, 4 June 1989, B.J. Carter 400 (DNA, PERTH); Canning Stock Route, near Durba Spring, 26 Aug. 1995, M.G. Corrick 11136 (CANB, MEL, PERTH); Rudall River National Park, towards E boundary and S of main track, 22 July 2003, D.J. Edinger & G. Marsh DJE 3660 (PERTH); Broome area, 13 Oct. 1984, P.R. Foulkes 46 (PERTH); Near Sally May well site, Great Sandy Desert, 28 June 2009, G.F. Griffin & S.R. Dunlop GSD 09-117 (PERTH); Gogo Station, 8 Oct. 1952, K. Fitzgerald 1 (PERTH); Site D1, near Edgar Range, SE of Broome, 13 Aug. 1976, K.F. Kenneally 5655 (CANB, PERTH); 4 km S of Cape Bertholet, Dampierland, N of Broome, 20 Apr. 1977, K.F. Kenneally 6075 (CANB, PERTH); 156 km SW of Halls Creek, 5 July 1989, K.F. Kenneally s.n. (BRI, PERTH); Myroodah Station, Oct. 2011, P. Knapton 23 (PERTH); 99 km E of Fitzroy Crossing, 1 July 1983, C. MacDonald 420 (BRI); Dampier’s Land near Broome, July 1911, E. Mjöberg s.n. (NSW); 100 km E of Fitzroy Crossing along the Great Northern Highway, 12 Sept. 1982, N.F. Norris 872 (CBG, MEL, NSW, PERTH); c. 10 km SW of Mandora Homestead near the top of a pindan rise, 5 Apr. 1995, H. Pringle PRP326 (PERTH); Roebuck Bay, May 1890, J.G.O. Tepper 125 (AD, n.v., MEL); 1 km S of Broome Bird Observatory, c. 25 km from Broome, 25 June 1997, T.L. Woodburn s.n. (CANB).

**Distribution:** Scattered but relatively common from Broome and Mandora in the west, north to Ngumban Cliffs, ENE of Fitzroy Crossing and south east to Kiwirrkura in Western Australia (Figure 8A).

**Habitat:** Grows on red sand flats and commonly on sand dunes, usually on deep sands. Associated species include *Acacia eriopoda*, *A. hippuroides*, *A. monticola*, *A. tumida* var. *kulparn*, *Chamaecrista symonii*, *Corymbia chippendalei*, *C. polycarpa*, *C. zygophylla*, *Dicrastylis doranii*, *Eragrostis falcata*, *Gyrostemon tepperi*, *Jacksonia aculeata*, *Melaleuca lasiandra*, *Newcastelia cladotricha*, *Scaevola parvifolia*, *Solanum cunninghamii*, *Triodia basedowii*, *T. bitextura*, *T. pungens* and *Ventilago viminalis*.

**Phenology:** Flowers mostly between June and October, but also as early as March.

**Conservation status:** *Corynotheca gracilis* is widespread and is not currently considered threatened.

**Common name:** Slender Zigzag Lily.

**Etymology:** The specific epithet is from the Latin *gracilis* (slender, fine), in reference to the slender inflorescence branches.

**Affinities:** *Corynotheca gracilis* is closely related to *C. borealis*, differing in the racemule internodes diverging at 110–140° (vs 80–100°); pedicels 1.0–3.1 (vs 0.9–1.3) mm long; sepals 1.1–1.4 (vs 0.8–0.9) mm wide, petals 1.4–1.5 (vs 0.7–0.8) mm wide and staminal filaments 1.9–4.0 (vs 1.4–2.1) mm long.

This pair may have affinity to the only other tropical species, *C. lateriflora* (R.Br.) F.Muell. ex Benth. rather than *C. micrantha* (Lindl.) Druce based on the larger perianth, seeds and tropical distribution. *Corynotheca gracilis* can be readily distinguished from *C. lateriflora* by the racemules with axis not or slightly tortuous (vs tortuous), 20–60 (vs 65–175(–250)) mm long, with 2–5 (vs 4–7) nodes, each node divaricate at 110–140° (vs diverging at 170–180°) and internodes 5–23 (vs 7–31(–40)) mm long.

*Corynotheca gracilis* differs from *C. micrantha* by the fleshy-fibrous roots (vs fibrous), basal leaves 7–15(–20) (vs 28–105) mm long, racemule internodes diverging at 110–140° (vs 130–180°), 0.2–0.4 (vs 0.3–0.6) mm wide, perianth 4.0–6.5 (vs 2.8–4.5) mm long, staminal filaments 1.9–4.0 (vs 1.7–2.1) mm long and seeds 3.4–4.7 (vs 2.3–3.4) mm long.

**Notes:** Henderson (1987) commented that “this taxon may prove to be specifically distinct from *C. micrantha*.” A larger range of available specimens has enabled both taxa to be refined in circumscription and distribution, and species rank is considered appropriate for Henderson’s variety.

***Corynotheca lateriflora*** (R.Br.) F.Muell. ex Benth., *Fl. Austral.* 7: 49–50 (1878); *Caesia lateriflora* R.Br., *Prodr.* 277 (1810).

Type: Carpentaria Is. h & g [North Is. and Vanderlin Is., Sir Edward Pellew Group, Northern Territory], 16–26 December 1802, R. Brown [Bennett no. 5691] (lectotype designated by R.J.F.Henderson, *Fl. Austral.* 45: 474 (1987): BM 000990667 (right hand piece)\*; presumed isolecto: BM 000990664\*, BM 000990665\*, BM 000990666\*, BRI AQ0022990, CANB 279207, G 00165666\*, K 000794734\*, MEL 107057, MEL 107058, P 00852453\*, P 00852454\*, P 00852455\*).

Illustrations: Henderson (1987; figs 70d, 96a).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, 50–120 mm long, thin fleshy-fibrous, not sand-binding. *Stems* to 30 mm long and 7 mm diam. *Leaves* several, linear-subulate, (40–)120–220 mm long, 0.6–2.2 mm wide, flat to convolute, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, to 75(–100) cm long, grey-green to dark green; peduncle erect to ascending, subterranean at base; major branches spreading to decumbent; lowest branch 2–5(–11) cm from rhizome; panicle branches divergent, each node divergent at 90–150°; racemules with axis tortuous, 65–175(–250) mm long, with 4–7 nodes, each node diverging at 170–180°, finely ribbed, but otherwise smooth; internodes 7–31(–40) mm long, 0.1–0.6 mm wide, ±straight; flowers solitary in branch axils; lower bracts linear-subulate, 16–50 mm long, acuminate, sometimes stiff; uppermost bracts ovate-attenuate, 1.2–5.1 mm long; pedicels 1.4–2.0(–3.0) mm long. *Perianth* 6.5–8.0 mm long, segments connate for c. 0.6 mm, spirally twisting after anthesis, deciduous. *Sepals* linear to narrowly oblong, 6.4–7.9 mm long, 1.1–1.6 mm wide, apex apiculate, with a minute appendage c. 0.6 mm long, margins white, median band darker, pink to purplish to brown. *Petals* narrowly elliptic, 6.2–7.8 mm long, 1.6–2.0 mm wide, emarginate, margins white to cream, median band darker, pale mauve or pink. *Filaments* slightly spreading, kinked to almost straight, unequal, 3.2–4.1 mm long, dilated and minutely papillose, yellow; anthers 0.7–1.0 mm long. *Style* filiform, to 4.2 mm long, subequal to exceeding stamens. *Capsule* erect to pendulous, clavate-attenuate, 7–15 mm long, 2.0–4.1 mm wide, brown, slightly wrinkled. *Seed* 1(2) per fruit, 5.0–6.8 mm long, 1.8–2.0 mm wide, glossy black to iridescent, longitudinally striate; caruncle conical distally, the lobes free (Figures 4a, 16).

**Diagnostic characters:** Leaves (40–)120–220 mm long, perianth 6.5–8.0 mm long, seeds 5.0–6.8 mm long.

**Selected specimens examined:** NORTHERN TERRITORY: 10 July 1972, 37 miles S of Oenpelli, 10 July 1972, L.G. Adams 2794 (CANB, DNA, *n.v.*); Boggy Plain Creek near Jabiru, 21 Feb. 1973, L.G. Adams 3051 (BRI, CANB, DNA, *n.v.*, NSW); near Finnis River, 9 Sept. 1946, S.T. Blake 16748 (CANB, DNA, *n.v.*); 8 miles NE of Wangi Homestead, 26 Aug. 1969, N. Byrnes 1673 (BRI, CANB, CBG, DNA, *n.v.*, MEL, NSW); c. 22.4 mi. SE of Darwin, 27 May 1958, G. Chippendale 4480 (DNA, *n.v.*, NSW); Arnhem Land. c. 18 km ESE of Ramingining, 21 June 2001, I.D. Cowie 9408 (BRI, CANB, DNA, *n.v.*, MEL); west side of South West Island, Sir Edward Pellew Group, 9 Feb. 1976, L.A. Craven 3734 (CANB, DNA, *n.v.*); 10 km south-east of Nourlangie Ranger Station on Pine Creek road, 21 May 1980, L.A. Craven 5702 (BRI, CANB, DNA, *n.v.*, MEL); Tabletop Range, 19 May 1985, C.R. Dunlop 6792 (DNA, *n.v.*, MEL, RSA, *n.v.*); c. 43.9 km NNE of Pungalina Homestead on Skeleton Creek Road from Calvert River mouth to Robson River mouth on Pungalina/Seven Emu Wildlife Sanctuary, 25 July 2012, R. Jensen 2707 & J. Kemp (BRI); Mount Brockman Outlier 15 km SE of Jabiru along Baroalba Creek, 20 Apr. 1989, R.W. Johnson 4719 (AD, *n.v.*, BRI, CANB, DNA, *n.v.*, NSW); 44 km SE Oenpelli, 15 June 1978, P.K. Latz 7803 (AD, *n.v.*, CANB, DNA, *n.v.*); Goyder River Crossing, 16 June 1972, J.R. Maconochie 1476 (AD, *n.v.*, CANB, DNA, *n.v.*, MEL, PERTH); Gulf of Carpentaria, 1856, F. Mueller *s.n.* (MEL 0107071); Koongara, 16 Apr. 1979, B.L. Rice 3132 (BRI, DNA, *n.v.*); Kakadu National Park, Upper Koolpin Creek, 9 June 1988, J. Russell-Smith & D. Lucas 5537 (BRI, CANB, DNA, *n.v.*); Oenpelli Reserve, 26 Apr. 1980, D. Smyth OP 10.7 (BRI); Oenpelli, 24 Sept. 1948, R.L. Specht 1057 (AD, *n.v.*, BRI, CANB, MEL, NSW, PERTH); Vanderlin Island, 2 km E of Lake Eams, Sir Edward Pellew Group, 23 July 1988, B.G. Thomson 2490 (BRI, DNA, *n.v.*, NT, *n.v.*); Little Nourlangie Rock, 7 May 1983, K.L. Wilson 5195 & C. Dunlop (DNA, *n.v.*, MEL, NSW).

**Distribution:** Endemic to the Northern Territory with two disjunct regions of distribution in the ‘Top End’ and near the Queensland border in the Gulf of Carpentaria (Figure 8A).

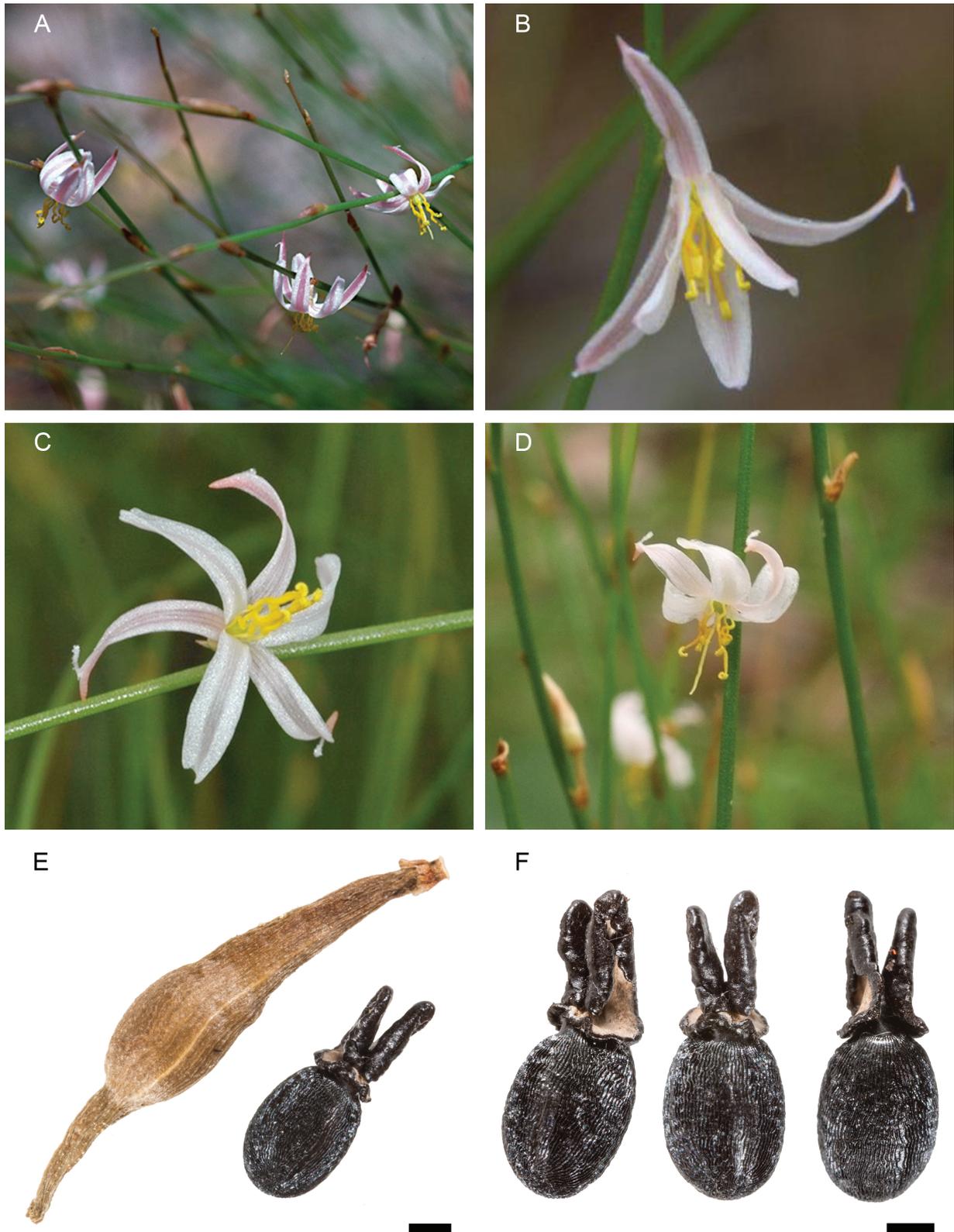
**Habitat:** Grows on damp white, grey or yellow sands along creek margins, on flats and around sandstone outcrops in woodland with *Acacia* sp., *Alphitonia* sp., *Aphyllodium biarticulatum*, *Aristida holathera*, *Banksia dentata*, *Centrolepis exserta*, *Corymbia ferruginea*, *Drosera* sp., *Eragrostis* sp., *Eriachne burkittii*, *E. trisetata*, *Eucalyptus miniata*, *E. tetradonta*, *Eulalia* sp., *Grevillea pteridifolia*, *Hibbertia complanata*, *Leschenaultia* sp., *Melaleuca nervosa*, *Mitrasacme* sp., *Pandanus spiralis*, *Phyllanthus* sp., *Pteris platyzomopsis*, *Sacciolepis myosuroides*, *Schizachyrium* sp., *Spermacoce* sp., *Triodia lanosa*, *Utricularia* sp. and *Uvedalia linearis* var. *lutea*.

**Phenology:** Flowers mostly February–July, but recorded all year round.

**Conservation status:** *Corynotheca lateriflora* is widespread and is not currently considered threatened.

**Common name:** Club-fruit Lily, Sand Lily.

**Etymology:** The specific epithet is from the Latin *lateri-* (at the side) and *flora* (flower), in reference to the sessile flowers that appear lateral to the racemules.



**Fig 16.** *Corynotheca lateriflora*. A. Flowering branches. B–D. Flower; E. Fruit and seed. F. Seeds. Vouchers: A. Litchfield National Park, *I. Cowie* 14109 (DNA); B. Coburg Peninsula, *I. Cowie* 10430 (DNA); Litchfield National Park, *B. Stuckey* 109 (DNA); D. Gurig (Coburg Peninsula) National Park, *K. Brennan* 6902 (DNA); E, F: Maningrida, *A.N. Rodd* 2914 (NSW). Scale = 1 mm. Photographs by *I. Cowie* (A, B), *B. Stuckey* (C), *K. Brennan* (D), *R. Barrett* (E, F).

**Affinities:** *Corynotheca lateriflora* is readily distinguished from all other species in the genus by the large perianth 6.5–8.0 (vs 1.4–6.5) mm long and seeds 5.0–6.8 (vs 1.8–4.7) mm long.

Possibly most closely related to *C. licrota* which differs in having fibrous (vs fleshy-fibrous) roots, persistent (vs dry at anthesis) basal leaves 2.5–4.1(–9) (vs 0.6–2.2) mm wide, 5–17 (vs 4–7) nodes per racemule, racemules 0.4–1.3 (vs 0.1–0.6) mm diam., perianths 4.3–6.0 (vs 6.5–8.0) mm long, and seeds 3.0–4.3 (vs 5.0–6.8) mm long with colliculate (vs folded) caruncle lobes.

**Notes:** While Mueller (1870: 68) suggested this species might be best placed in *Corynotheca*, the combination was only validated by Bentham (1878: 49).

Robert Brown's unpublished collection notes indicate that he observed this species on both Carpentaria Islands 'h' and 'g' [North Is. and Vanderlin Is. in the Sir Edward Pellew Group], but the available specimens do not indicate whether collections were made on both islands, or only one. For this reason, Henderson (1987: 474) selected a single piece on a single sheet at BM as the lectotype. It is presumed that some, or possibly all, of the additional sheets are therefore isolectotypes, but we cannot be certain given this history.

Many early treatments included *Corynotheca licrota* under *C. lateriflora*, the two first being separated at varietal rank by Gauba (1948) and subsequently separated at species rank by Henderson (1987).

The stems and leaves are recorded as being used to flavour meat during cooking in the Northern Territory (Smith 1991). The collection *D. Smyth OP 10.7* is recorded as being utilised as a seasoning called *Manbunbarra* near Oenpelli. Similarly, oral history records that *Corynotheca licrota* was called *Bunbarr* by the Bininj Kunwok people of West Arnhem Land, and used as a herb to cook emu in ground ovens (Nakardbam 2013).

Previous records from Western Australia are referable to either *C. borealis* or *Tricoryne* sp. Kimberley (K.F. Kenneally 4857).

***Corynotheca licrota*** R.J.F.Hend., *Fl. Austral.* 45: 474, 300–301, figs 70e, 96b (1987); *Corynotheca lateriflora* var. *laevisperma* Gauba, *Vict. Nat.* 65: 111, 113 (1948).

Type: Mount Dispersion, Murray River, New South Wales, December 1853, *F. Mueller s.n.* (holo: MEL 107234).

Possible isotypes: 'Murray', *F. Mueller* (?iso: MEL 106891); 'Sandridges on the River Murray', *F. Mueller* (?iso: MEL 107232).

*Corynotheca lateriflora* auct. non (R.Br.) F.Muell. ex Benth.; E.Gauba, *Vict. Nat.* 65: 111 (1948), *p.p.*; J.P.Jessop in J.P.Jessop & H.R.Toelken (eds), *Fl. S. Austral.* Edn. 4, 4: 1752 (1986), *p.p.*

Illustrations: Gauba (1948; fig. p. 112), as *C. lateriflora*; Cunningham *et al.* (1981; pl. p. 183), as *C. lateriflora*; Henderson (1987; figs 70e, 96b).

Tufted, erect, rhizomatous *perennial*, glabrous. *Roots* many, 40–80 mm long, fibrous, not sand-binding. *Stems* short, to 5 mm long and 2.5 mm diam. *Leaves* several, linear-subulate, 50–300(–600) mm long, 2.5–4.1(–9) mm wide, flat or complicate, reducing rapidly to bracts upwards, persistent, basal, erect. *Inflorescence* perennating, irregularly paniculate, to 70 cm long, bright green; peduncle erect to ascending, subterranean at base; major branches divergent; lowest branch 10–25 cm from rhizome; panicle branches diverging, each node diverging at 130–160°; erect to ascending; racemules with axis tortuous, 75–300 mm long, with 5–17 nodes, each node continuous (at ±180°), finely ribbed, but otherwise smooth; internodes 4–25 mm long, 0.4–1.3 mm wide, ±straight; flowers solitary (rarely 2) in branch axils; lower bracts linear-subulate, 40–200 mm long, acuminate; uppermost bracts ovate-attenuate, 1.5–7 mm long; pedicels 1.2–2.6 mm long. *Perianth* 4.3–6.0 mm long, segments connate for c. 0.4 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly oblong, 4.0–5.9 mm long, 0.9–1.1 mm wide, apex apiculate, with a minute appendage c. 0.8 mm long, white to pink to purplish to brown, median band darker. *Petals* narrowly elliptic, 3.9–5.5 mm long, 0.7–0.9 mm wide, emarginate, white to cream, median band darker. *Filaments* slightly spreading, straight, subequal, 1.7–2.2 mm long, dilated and minutely papillose, yellow; anthers 0.5–0.8 mm long. *Style* filiform, to 3.8 mm long, exceeding stamens. *Capsule* pendulous, ovoid to obovoid, 2.8–7.5 mm long, 2.1–2.8 mm wide, brown, slightly wrinkled. *Seeds* 1–5 per fruit, 2.7–4.3 mm long, 1.3–1.5 mm wide, glossy black to iridescent, smooth to finely longitudinally striate; caruncle spreading distally, the lobes free, folded, antler-like (Figure 17).

**Diagnostic characters:** Mature basal leaves persistent at anthesis, 2.5–4.1(–9) mm wide, inflorescence axes and racemules smooth, finely ribbed, racemules consistently continuous at ±180, pedicels 1.2–2.6 mm long, caruncle lobes on seeds free.



**Fig. 17.** *Corynotheca licrota*. A–C. Habit. D. Flowering racemule. E. Fruit. F. Seed with antler-like caruncle. Vouchers: A, E: Berri, *M.J. Thorpe* 368 (AD); B, D: Mamungari, *D.E. Murfet* 7736 (AD); C: Mt Finke, *D.J. Duval* 1672 (AD); F: *D.J. Duval* 877 (AD). Scale = 1 mm. Photographs by the South Australian Seeds Conservation Centre (D. Duval).

**Selected specimens examined:** WESTERN AUSTRALIA: West end of Rawlinson Ranges, 72 km WNW of Warrakuma settlement, 17 Aug. 2016, *P.K. Latz 30876* (NT); NORTHERN TERRITORY: Finke River, 1880, *F.A.H. Kempe 371 E* (MEL 107275, MEL 107059); Erldunda Station, 26 Apr. 1974, *P.K. Latz 4970* (AD, *n.v.*, BRI, NT, *n.v.*, PERTH); Hermannsburg Mission, Finke Gorge, 1 Oct. 1977, *P.K. Latz 7506* (AD, *n.v.*, NT, *n.v.*, PERTH); 7 km NW Rainbow Valley visitors centre, 11 Nov. 2012, *P.K. Latz & S.M. Pullyblank 27529* (BRI, *n.v.*, NSW, NT, *n.v.*); 42 km E of Henbury Homestead, Northern boundary, 19 Feb. 2013, *P.K. Latz & A. Schubert 27692* (NSW, NT, *n.v.*); QUEENSLAND: ‘Gilruth Plains’, Cunumulla, 29 Sept. 1941, *G.H. Allen 191* (CANB); ‘Gilruth Plains’, Cunumulla, 8 Sept. 1942, *G.H. Allen 425* (CANB); SW of Charleville, 1 Dec. 1935, *S.L. Everist 1417* (BRI); Thylungra, c. 75 mi. NW of Quilpie, 11 Oct. 1955, *S.L. Everist 5706* (BRI, CANB); 7 km E of Gilruth Plains, 6 Oct. 1984, *R.W. Purdie 2166* (BRI); SOUTH AUSTRALIA: 2 miles N of Ooldea, 13 Oct. 1956, *N. Forde 675* (CANB); Loveday, 20 Dec. 1944, *E. Gauba s.n.* (MEL); c. 5 km NE of Overland Corner, 15 Nov. 2005, *D.E. Symon 17235* (AD, *n.v.*, MEL); NEW SOUTH WALES: 6.9 km E of Nulty Springs junction, ESE of Enngonia, 18 Sept. 2004, *A.R. Bean 23109* (BRI); Nulty Springs, 20 Nov. 1975, *G.M. Cunningham 4175* (CANB, NSW); E of Narran Lake, near Brewarrina, 22 Nov. 1967, *D.J. McGillivray 2924* (NSW); c. 40 km SE of Louth, 19 Nov. 1975, *C.W.E. Moore 7192* (CANB); ‘Tuudulya’, c. 40 km SE of Louth, 9 Oct. 1981, *C.W.E. Moore 8289* (CANB); 70 km NW of Balranald, Nov. 1974, *W.E. Mulham W 830, 835* (CANB, NSW); Pan Ban Station, 22 Oct. 1985, *B.L. Rice 4215* (NSW); Pan Ban Station, 17 Nov. 1985, *B.L. Rice 4298* (BRI); Cobb Highway, 24 km SSE of Barrier Highway, 2 Nov. 1986, *A.N. Rodd, J. Gentle & P.G. Wilson 5821* (AD, NSW); ‘Petro’, 40 miles NE of Mildura, Site 1, 6 Dec. 1978, *W.S. Semple 832* (NSW); VICTORIA: Hattah Lakes National Park, near old highway and NW of Lake Hattah, 16 Oct. 1960, *A.C. Beauglehole 39276 & J.H. Willis* (MEL); Between Sunset Tank and Monkeytrail Tank, 15 Nov. 1986, *D.C. Cheal s.n.* (MEL 687803); Murray Sunset National Park, beside Rocket Lake, about midway along and c. 60 m E from the eastern ‘shore’, 24 Nov. 2011, *N.G. Walsh 7479, J.L. Birch, C.L. Gallagher & S. Stewart* (CANB, MEL, PAL, *n.v.*, S, *n.v.*).

**Distribution:** Relatively widespread in the arid zone of southern Australia, in all mainland states, with three somewhat disjunct population areas in the central ranges, Murray-Darling Basin and in southern South Australia. This species has a somewhat remarkable distribution in eastern Australia that clearly tracks the drainage of the Darling and lower Murray Rivers, suggesting possible hydrochory (distribution of seed by water) from inland Australia (Figure 8B).

**Habitat:** Grows on sand dunes, sandy plains or occasionally on shallow sand over quartzite with *Acacia ligulata*, *A. melleodora*, *A. spondylophylla*, *Actinotus paddisonii*, *Allocasuarina decaisneana*, *Angophora melanoxylon*, *Aristida holathera*, *Austrostipa* sp., *Babingtonia behrii*, *Calandrinia balonensis*, *Calotis erinacea*, *Chrysocephalum apiculatum*, *Codonocarpus cotinifolius*, *Crinum flaccidum*, *Dicrastylis costelloi*, *Dodonaea viscosa*, *Enchylaena tomentosa*, *Eragrostis eriopoda*, *Eremophila willsii*, *Eucalyptus dumosa*, *E. gamophylla*, *E. incrassata*, *E. melanophloia*, *E. socialis*, *Gnephosis tenuissima*, *Grevillea juncifolia*, *Leptospermum coriaceum*, *Phyllota pleurandroides*, *Ptychosema stipulatum*, *Sclerolaena diacantha*, *S. obliquicuspis*, *Swainsona microphylla*, *Triodia basedowii*, *T. irritans*, *T. marginata*, *T. mitchellii*, *T. pungens* and *T. scariosa*.

**Phenology:** Flowers mostly September–February, but also recorded in April and August following rainfall.

**Conservation status:** While *Corynotheca licrota* is widespread as a species, it is only known from a single collection in Western Australia where it is recommended for listing as a Priority 1 taxon, and scattered distributions provide justification for listing as Near Threatened in the Northern Territory, Rare in Victoria and Rare in South Australia.

**Common names:** Antler Zigzag Lily, Club-fruit Lily, Sand Lily.

**Etymology:** The specific epithet is from the Greek *likros* (antler) and *-ota* (resemblance), in reference to the barbellate, antler-like caruncle on the seeds.

**Affinities:** *Corynotheca licrota* may be most closely related to *C. lateriflora*, differing in having fibrous (vs fleshy-fibrous) roots, persistent (vs dry at anthesis) basal leaves 2.5–4.1(–9) (vs 0.6–2.2) mm wide, 5–17 (vs 4–7) nodes per racemule, racemules 0.4–1.3 (vs 0.1–0.6) mm diam., perianth 4.3–6.0 (vs 6.5–8.0) mm long and seeds 3.0–4.3 (vs 5.0–6.8) mm long with colliculate (vs folded) caruncle lobes.

**Notes:** While MEL 106891 is simply labelled with the location ‘Murray’, and MEL 107232 with ‘Sandridges on the River Murray’, duplicate sheets of Mueller’s collections often had much-reduced labels and the material is very similar to the holotype, so they are considered possible isotype material.

Henderson (1987) recorded 2–6 flowers per node, but no specimens were seen matching this observation, most being solitary, and just a few flowers were paired. This may be a carry-over from previous literature based on a misidentified *Caesia* collection. This relatively rare species is not often seen flowering. Observations in Victoria suggest that flowers open late in the day (Eichler 2018). It has been observed with open flowers at various times

of the day in South Australia (D. Duval, pers. comm.) and flowering is probably influenced by specific daily conditions, especially heat, so they may close early the following day unless conditions are favourable. The seasonality of flowering appears to be heavily influenced by rainfall and soil moisture (Eichler 2018).

The leaf bases of this species become fibrous with age, similar to those of *Caesia viscida* Keighery, which has a similar habit to *Corynotheca licrota*.

***Corynotheca micrantha*** (Lindl.) Druce, *Bot. Exch. Club* 1916, *Suppl.* 2: 616 (1917); *Asparagus micranthus* Lindl., *Edwards's Bot. Reg.: Sketch Veg. Swan R. Colony* lviii (1840), non Siebold & Zucc. ex Baker (1875); *Corynotheca micrantha* (Lindl.) J.F. Macbride, *Contr. Gray Herb.* 56: 3 (1918), *nom. superfl.*

Type: Swan River, Western Australia, 1839, *J. Drummond s.n.* (holo: CGE, *n.v.*, photos at BRI, PERTH).

*Thysanotus micranthus* Endl. in Lehmann, J.G.C. (ed.), *Pl. Preiss.* 2(1): 36 (1846).

Type: In arenosis supra oppidulum Perth, Western Australia, 28 November 1839, *L. Preiss* [*Plantae Preissianae* No. 1576] (lectotype here designated: LD 1067334\*; isolecto: MEL 107503).

Residual syntype: Wellington district, Western Australia, December 1839, *L. Preiss* [*Plantae Preissianae* No. 1566] (syn: LD 1056262\*; MEL 107502).

*Thysanotus micranthus* var. *minor* Endl. in Lehmann, J.G.C. (ed.), *Pl. Preiss.* 2(1): 36 (1846).

Type: In arenosis supra oppidulum Perth, Western Australia, 28 November 1839, *L. Preiss* [*Plantae Preissianae* No. 1576] (holo: LD 1067334\*; iso: MEL 107503).

*Thysanotus micranthus* var. *major* Endl. in Lehmann, J.G.C. (ed.), *Pl. Preiss.* 2(1): 36 (1846).

Type: Wellington district, Western Australia, December 1839, *L. Preiss* [*Plantae Preissianae* No. 1566] (holo: LD 1056262\*; iso: MEL 107034, MEL 107502, P 00852456\*, S 06-3249\*).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, at least 50 mm long, fleshy-fibrous, sand-binding. *Stems* clonal, 10–20 cm long and 1.5–2.4 mm diam. *Leaves* few, linear-subulate, 28–105 mm long, 0.6–1.6 mm wide, flat to involute, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, irregularly paniculate, interrupted, evenly diffuse, 30–80 cm long, dark green; peduncle ascending, subterranean at base; major branches ascending to spreading to decumbent; lowest branch 1–8 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 80–150°; racemules with axis tortuous, 12–40 mm long, with 2–4 nodes, each node divergent at 130–180°, finely ribbed, but otherwise smooth; internodes 4–12 mm long, 0.3–0.6 mm wide, straight to gently curving; flowers solitary in branch axils, most developing; lower bracts linear-subulate, 9–35 mm long, acuminate; uppermost bracts obovate to ±triangular, 0.7–2.6 mm long; pedicels 1.2–2.9 mm long. *Perianth* 2.8–4.5 mm long, segments connate for c. 0.4 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly oblong, 2.6–4.4 mm long, 1.0–1.1 mm wide, apex apiculate, with a minute appendage c. 0.1 mm long, margins white, median band darker, pink to purplish. *Petals* narrowly oblong, 2.5–4.3 mm long, 0.9–1.0 mm wide, acute, margins white to cream, median band slightly darker. *Filaments* held erect, straight or slightly incurving, subequal, 1.7–2.1 mm long, somewhat dilated, minutely papillose, white; anthers 0.4–0.8 mm long. *Style* filiform, to 2.0 mm long, equalling or exceeding stamens. *Capsule* nodding, obpyriform, 3.5–5.5 mm long, c. 1.5 mm wide, brown, slightly wrinkled. *Seed* 1(2) per fruit, 2.3–3.4 mm long, c. 1.2 mm wide, glossy black to iridescent, longitudinally striate; caruncle conical distally, the lobes fused. *2n* = 42 (G.J. Keighery, *Feddes Repert.* 95: 527 (1984); Keighery 2074) (Figures 3b, 18).

**Diagnostic characters:** Basal leaves 28–105 mm long, inflorescence branches flexible, racemules 12–40 mm long, internodes diverging at 130–180°, slender, ±flexible, straight to diverging, not pungent, 0.3–0.6 mm wide, perianth 2.8–4.5 mm long, seeds 2.3–3.4 mm long.

**Selected specimens examined:** WESTERN AUSTRALIA: Lake Mealup, 25 km W of Pinjarra, 20 Nov. 2004, *K.E. Creed* 173 (CANB, PERTH); 14.6 km E along Kondinin–Hyden Road from Kondinin, 5 Apr. 2001, *R. Davis* 9694 (PERTH); Lot 505 Hungerford Avenue, Halls Head, Dec. 2001, *P. Foreman* 360 (PERTH); Kingsway Sporting Complex, City of Wanneroo, 22 Nov. 2005, *G. Guerin* & *G. Busby* GG 155 (CANB, PERTH); Western Titanium leases, 8 km S of Eneabba, 18 Sept. 1977, *R.J. Hnatiuk* 771228 (PERTH); c. 5 km W of Brand Highway Beermullah West Road, 24 Nov. 1995, *B.J. Keighery* 2115 (PERTH); Bayswater, Lower Swan River, 27 Nov. 1897, *A. Morrison* 7330 (BRI); 'Sub' [Subiaco], 19 Jan. 1901, *A. Morrison s.n.* (BRI AQ053436); 'C' [Cannington], 26 Dec. 1901, *A. Morrison s.n.* (BRI AQ053435); Claremont, 6 Nov. 1907, *A. Morrison s.n.* (CANB 00594975); Mogumber, Moore River, 14 Nov. 1906, *A. Morrison* 16225 (PERTH); Marchagee Nature Reserve, Midlands Highway, S of Coorow, 27 July 1999, *F. Obbens* 133/99 (PERTH).



**Fig. 18.** *Corynotheca micrantha*. A, B. Habit. C. Flowering branches. D, E. Flowers. F. Fly visiting flower. Vouchers: A: Gnangarra (not vouchered); B, C, E: Kings Park, Perth (not vouchered); D: Mount Lawley, Perth, K.R. Thiele 3127 (PERTH); F: Beeliar Bushland (not vouchered). Photographs by A: R. Cumming; B: R.L. Barrett; C, E: E. Pin Tay; D: K. Thiele; F: M. Brundrett.

**Distribution:** From Eneabba south to Dunsborough and inland to Kondinin in Western Australia, but mostly restricted to the coastal plain and adjacent sand lenses along the Darling Range (Figure 8B).

**Habitat:** Grows on white, grey and yellow sands, sometimes over limestone or laterite, commonly in *Banksia* woodland with *Acacia pulchella*, *Allocasuarina huegelii*, *A. humilis*, *Austrostipa flavescens*, *Banksia attenuata*, *B. burdettii*, *B. prionotes*, *B. sessilis*, *Burchardia congesta*, *Caesia micrantha*, *Corymbia calophylla*, *Daviesia triflora*, *Eremaea pauciflora*, *Eucalyptus foecunda*, *E. gomphocephala*, *Hakea prostrata*, *H. trifurcata*, *Jacksonia* spp., *Lepidosperma calcicola*, *Macarthuria australis*, *Mesomelaena pseudostygia*, *Synaphea spinulosa*, *Xanthorrhoea brunonis*, and *X. preissii*.

**Phenology:** Flowers mostly June–January.

**Conservation status:** *Corynotheca micrantha* is relatively widespread, locally common and is not currently considered threatened, though its habitat on the Swan Coastal Plain has been significantly reduced by urban and agricultural development.

**Common names:** Hexagon Zigzag Lily, Sand Lily.

**Etymology:** The specific epithet is from the Greek *micro-* (little, small) and *anthos* (flower), in reference to the small flowers of this species relative to related genera.

**Affinities:** *Corynotheca micrantha* may be most closely related to *C. elongata*, which has a largely overlapping range, differing in the longer basal leaves 28–105 (vs 5–34) mm long, shorter racemules 12–40 (vs 37–78) mm long and fewer nodes 2–4 (vs 4–8) per racemule.

*Corynotheca acanthoclada* may also be closely related to *C. micrantha*, most readily distinguished by the relatively short racemes that are rigid, with pungent apices.

**Notes:** While previously included under *C. micrantha*, we consider the varieties recognised by Henderson (1987) to be equally as distinct as other species recognised in the genus based on a morphological assessment of taxa.

Macbride (1918) independently made the combination *Corynotheca micrantha* (Lindl.) J.F. Macbride, *Contr. Gray Herb.* 56: 3 (1918), but this is superfluous as it was preceded by Druce (1917).

Endlicher (1846) named *Thysanotus micranthus* with two varieties, var. *minor* Endl. and var. *major* Endl. Specimens were only cited under the varieties, so one must be a nomenclatural synonym of the typical variety. As var. *major* was noted to be “An species propria?”, it is here interpreted that Endlicher considered var. *minor* to be the typical variety, so a lectotype is designated here to reflect this intent. The lectotype is a good specimen from Lehmann’s herbarium (now in LD), while the isolectotype is from Sonder’s herbarium (now in MEL).

This species shows a remarkable superficial similarity to *Drimia intricata* (Baker) J.C. Manning & Goldblatt, a bulbous Asparagaceae from southern Africa that Thunberg proposed to name ‘*Asparagus micranthus*’ on herbarium sheets, but apparently did not formally publish. Jessop (1977) listed ‘*Asparagus micranthus* Thunb.’ as a synonym of *Schizobasis intricata* (Baker) Baker (= *Drimia intricata*), but did not validate the name in doing so.

***Corynotheca panda*** (R.J.F.Hend.) R.L. Barrett & T. Macfarlane, *comb. et stat. nov.*

Basionym: *Corynotheca micrantha* var. *panda* R.J.F.Hend., *Fl. Austral.* 45: 475, 303, fig. 70g (1987).

Type: junction of Martin Creek with Fitzgerald River, Reserve 24048, Western Australia, 19 December 1970, A.S. George 10576 (holo: PERTH 01221515; iso: PERTH 01221523).

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, 60–170 mm long, fleshy-fibrous, sand-binding. *Stems* short, to 15 mm long and 5 mm diam. *Leaves* few, linear-subulate, to 45–180 mm long, 0.7–1.6 mm wide, flat, reducing rapidly to bracts upwards, all usually senesced by anthesis. *Inflorescence* perennating, interrupted, subunits reduced to elongated simple or few-branched branches, 30–50 cm long, dark to olive green; peduncle erect to ascending to decumbent, subterranean at base; major branches spreading to decumbent; lowest branch 11–32 cm from rhizome; panicle branches diverging, each node diverging at (90–)130–170°; racemes with axis irregularly curving to tortuous, 18–106 mm long, with (2–)5–8 nodes, each node divergent at 140–180°, finely ribbed, but otherwise smooth or crenulate; internodes 8–19 mm long, 0.3–0.7 mm wide, ±straight to evenly curving; flowers solitary or paired in branch axils, few–many developing; lower bracts linear-subulate, 7–25 mm long, acuminate; uppermost bracts narrowly ±triangular, 1.0–2.1 mm long; pedicels 1.3–2.9(–3.5) mm long. *Perianth* 3.5–4.6 mm long, segments connate for c. 0.7 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly oblong, 3.3–4.5 mm long, 0.7–1.2 mm wide, apex apiculate, with a minute appendage c. 0.5 mm long, white at the base, grading to pink to purplish to brown, median band slightly darker. *Petals* narrowly oblong, 3.2–4.3 mm long, 0.6–0.8 mm wide, acute, white to cream, median band slightly darker. *Filaments* slightly spreading, straight or slightly incurving, subequal, 1.7–2.0 mm long, slightly dilated, minutely papillose, white; anthers 0.5–0.6 mm long. *Style* filiform, to 1.8 mm long, slightly exceeding stamens. *Capsule* spreading to antrorse, obpyriform, 3.8–5.2 mm long, 1.6–1.9 mm wide, brown, slightly wrinkled. *Seed* 1 per fruit, 2.8–3.3 mm long, c. 1.6 mm wide, glossy black to iridescent, longitudinally striate; caruncle conical distally, the lobes fused. (Figures 4b, 19)

**Diagnostic characters:** Basal leaves 45–180 mm long, racemes with (2–)5–8 nodes, internodes diverging at 140–180°, internodes 8–19 mm long, 0.3–0.7 mm diam., ±straight to evenly curving, seeds 2.8–3.3 mm long.

**Selected specimens examined:** WESTERN AUSTRALIA: Walpole Nornalup National Park, 13 Dec. 1988, A.R. Annel 532 (PERTH); Lort River crossing, c. 70 km W of Esperance along road to Ravensthorpe, 8 Jan. 1979, B. Barnsley 409 (CBG); Taylor Island, Recherche Archipelago, 5 Jan. 2011, S. Barrett & E. Adams 1929 (PERTH); near Israelite Bay, Dec. 1884, S.T. Brooks s.n. (MEL 107051); Cape Arid National Park camp ground on the western side of the Thomas River, 8 Nov. 2006, G. Byrne 2481 (PERTH); Jorndee Creek campsite, Condingup, 10 Apr. 2007, G. Byrne 2621 (PERTH); Chillilup Pool on Pallinup River, 14 Jan. 1979, M.D. Crisp 5148 (CBG); 400 m W of Meerup River, 50 m S of track, 27 Feb. 1997, C. Day & P. Ellery P 75.3 (PERTH); Knoll overlooking ocean S of Elephant Rock carpark, William Bay National Park (Plot: wil5), 27 Nov. 1990, N. Gibson & M. Lyons 853 (PERTH); William Bay National Park, dunes above Madfish Bay carpark, 18 Nov. 1990, B.G. Hammersley 489 (PERTH); Blackwood River, M. McHard s.n. (MEL 107052); Gold Holes, Chester Pass road, Stirling Ranges, 17 Nov. 1982, G.J. Keighery 5635 (PERTH); Pallinup River, Chillinup, 20 Apr. 2000, P.D. Moir 202 (PERTH); East of Hopetoun in first ten miles [16 km] of track, M.E. Phillips s.n. (CBG 11374); Eastern slope of Mount Arid, in saddle between saddle and large dome to East, 23 Nov. 1985, A.N. Rodd 5144 (BRI, CANB, MEL, NSW, PERTH); Helms Arboretum Bushland, 30 Mar. 2011, C.D. Turley & R.M. Hoggart 11/303-11 (CANB, PERTH); Lot 14 View Range Road, Tenterden, 75 m S of shed, 28 Dec. 2005, J.E. Wajon 1426 (PERTH).



**Fig. 19.** *Corynotheca panda*. A. Habit. B. Flowering branches. C. Flowering branchlet. D. Fruit. E. habitat. Vouchers: A, E: Cape Arid National Park, G. Byrne 2481 (PERTH); B, D, F: Seal Creek, G. Byrne 2621 (PERTH); C: Torbay Inlet, Albany, R. Davis 12989 (PERTH). Photographs by G. Byrne (A, B, D–F); R. Davis (C).

**Distribution:** Scattered along the south coast of Western Australia between the Blackwood River and Cape Arid, extending inland to the Stirling Ranges (Fig. 7).

**Habitat:** Grows on sandy or sandy clay soils, over siltstone or granite, in heath or open woodland with *Acacia saligna*, *Allocasuarina thuyoides*, *Comesperma flavum*, *Conospermum teretifolium*, *Eucalyptus rudis*, *E. tetraptera*, *Hibbertia oligantha*, *H. psilocarpa*, *Lechenaultia tubiflora*, *Leptospermum* sp., *Leucopogon* sp. Coujinup (M.A.Burgman 1085), *Lysinema ciliatum*, *Melaleuca pulchella*, *M. striata*, *Ornduffia parnassifolia*, *Schoenus caespititius*, *Stirlingia tenuifolia*, *Stylidium repens*, *Velleia trinervis* and *Xanthorrhoea platyphylla*.

**Phenology:** Flowers mostly between October–December.

**Conservation status:** *Corynotheca panda* is widespread and is not currently considered threatened.

**Common name:** Panda Zigzag Lily.

**Etymology:** The specific epithet is from the Latin *pandus* (bent), in reference to the curving racemule axes.

**Affinities:** *Corynotheca panda* appears to be most closely related to *C. elongata*, differing in the basal leaves 45–180 (vs 5–34) mm long, racemules diverging at 140–180° (vs diverging or straight (160–)170–180°), 0.3–0.7 (vs 0.2–0.5) mm diam., ±straight to evenly curving (vs ±straight) and seeds 2.8–3.3 (vs 1.8–2.7) mm long.

**Notes:** Henderson (1987) thought that this taxon may merge with *C. elongata*, and their geographical ranges do approach each other, but morphological intergradation has not been observed, and based on current collections, their ranges do not actually overlap.

*Corynotheca pungens* R.J.F.Hend., *Fl. Austral.* 45: 475, 304, figs 70k, 96h, i (1987).

Type: Gascoyne R., at crossing by North West Coastal Hwy, c. 15 km by road ENE of Carnarvon, Western Australia, 31 August 1977, *E.N.S. Jackson 3092* (holo: AD, *n.v.*; iso: BRI AQ0424269 [2 sheets], NSW, PERTH 01221485, PERTH 01221493, PERTH 01221507).

*Corynotheca lateriflora* var. *laevisperma* auct. non Gauba: E.Gauba, *Vict. Nat.* 65: 111, 113 (1948), *p.p.*

Tufted, tangled, rhizomatous *perennial*, glabrous. *Roots* many, at least 50 mm long, fleshy-fibrous, sand-binding. *Stems* not seen. *Leaves* single–many, mostly cauline, clustered at nodes, linear-subulate, to 40–110 mm long, 0.5–2 mm wide, flat, margins sometimes with scabrid hairs, reducing to bracts on upper branchlets, persistent. *Inflorescence* perennating, irregularly paniculate, 50–100 cm long, dark green; peduncle ascending to decumbent, subterranean at base; major branches decumbent; lowest branch 5–20 cm from rhizome; panicle branches dichotomously divaricate, each node divaricate at 90–150°; racemules with axis not twisted, 30–140(–300) mm long, with 5–21 nodes, each node divergent at 170–180°, finely ribbed, but otherwise smooth; internodes 3–14(–30) mm long, 0.6–1.1 mm wide, ±straight; flowers solitary in branch axils, ?few–most developing; lower bracts linear-subulate, 17–100 mm long, acute, pungent; uppermost bracts ovate-attenuate, 0.8–5.2 mm long; pedicels 0.9–1.7(–3.0) mm long. *Perianth* 2.7–6.1 mm long, segments connate for c. 0.5 mm, spirally twisting after anthesis, deciduous. *Sepals* narrowly elliptic, 2.6–5.8 mm long, 1.1–1.2 mm wide, apex apiculate, with a minute appendage c. 0.2 mm long, margins white, median band darker, pink to purplish to brown. *Petals* narrowly elliptic to obovate, 2.5–5.6 mm long, 0.9–1.0 mm wide, emarginate, white to cream, median band sometimes darker. *Filaments* erect to spreading, incurving, straight (i.e. not kinked), subequal to unequal 2.1–2.6 mm long, slightly dilated, minutely papillose, yellow; anthers 0.7–1.2 mm long. *Style* filiform, to 3.2 mm long, exceeding stamens. *Capsule* ascending to pendulous, clavate to obpyriform, 3.5–5.5 mm long, c. 1.7 mm wide, brown, slightly wrinkled. *Seeds* 1 or 2 per fruit, 2.7–2.9 mm long, c. 1.2 mm wide, glossy black to iridescent, (smooth or) longitudinally striate; caruncle conical distally, the lobes ±fused (Figures 5a, 20).

**Diagnostic characters:** Mature basal leaves mostly dry at anthesis but with mature cauline leaves not reduced to bracts, persistent, and clustered in major axils, 40–110 mm long, upper bract apices stiff, ±pungent, racemules 0.6–1.1 mm diam., caruncle lobes on seeds fused.

**Selected specimens examined:** WESTERN AUSTRALIA: 12 km SW of Onslow, 29 Aug. 2010, *J. Alford JJA 2009/3* (PERTH); Turee Creek Sandplain, S of Turee Creek Station, N Gascoyne, 27 Oct. 2000, *S. Black s.n.* (MEL, PERTH); Near sea wall, Port Hedland, 11 May 1941, *N.T. Burbidge 625* (PERTH); Ashburton River, 1883, *H.S. Carey s.n.* (MEL 107233); near Roebourne, *H.S. Carey s.n.* (MEL 107072); Strelly River, Aug.–Sept. 1907, *J.B. Cleland s.n.* (PERTH 1968343); Finucane Island, 15 Jul. 1981, *G. Craig 272* (PERTH); near Yule River, 1878, *J. Forrest s.n.* (MEL 107063); Sherlock River, 1878, *J. Forrest s.n.* (MEL 107069); Tuckanarra Creek, 13 Oct. 1945, *C.A. Gardner 7842* (PERTH); E of Learmonth Airfield, 8 Sept. 1970, *A.S. George 10346* (CANB, MEL, PERTH); Tent Island Nature Reserve, 29 July 2015, *N. Godfrey NG 1/15* (PERTH); Monkey Mia, Shark Bay, 30 Aug. 1989, *G.J. Keighery 10444* (CANB, PERTH); Mardathuna Station on main track to Binthalya

Homestead 2.5 km NNE of Yoveroo Well, 18 Aug. 1994, *G.J. Keighery & N. Gibson 1573* (CANB, PERTH); Old Onslow, 22 Aug. 2006, *G.J. Keighery & B.J. Keighery 762* (MEL, PERTH); coastal strip 5 km W of Urala Homestead, 30 km SE of Onslow, 14 Aug. 1992, *V. Long VL 439* (PERTH); 14.6 km NW of Wodgina Mining Centre, 35.2 SW of Indee Station Homestead and 37 km S of Wallareenya Station Homestead, 21 Mar. 2004, *M. Maier BES 598* (CANB, PERTH); 10–15 km E of Homestead in Giralia Station S of Exmouth Gulf, 13 June 2004, *K. McCreery GIR 04-13* (CANB, PERTH); c. 15 km NNW of De Grey Homestead on W side of De Grey River, 26 Sept. 1994, *A.A. Mitchell 3782* (PERTH); Onslow, Mouth of Ashburton River, 26 Sept. 1905, *A. Morrison s.n.* (BRI AQ053433); Banks of Ashburton River at Minderoo, 8 Oct. 1905, *A. Morrison 15163* (PERTH); Murchison River [presumably headwaters], *A.F. Oldfield s.n.* (MEL 107270, MEL 107070); 11 miles S of Carnarvon, 12 July 1959, *R.D. Royce 5854* (PERTH); Mardathuna Road, Kennedy Range National Park, 8 July 2015, *K.R. Thiele 5223* (PERTH); Peron Peninsula, Shark Bay, 2 Nov. 1989, *M.E. Trudgen 7503* (PERTH); 3.6 km NE of Red Hill, 5.6 km SW of Paruwarranha Hill, 25.5 km E of Whim Creek, Mundabullangana Station, 20 Aug. 2004, *S. van Leeuwen et al. PBS 5347* (PERTH).



**Fig. 20.** *Corynotheca pungens*. A. Habit. B. Flowering branches. C. Flowering branchlet. D. Fruit. Vouchers: A, B: east of Learmonth, *A.S. George 10346* (CANB); C: Kennedy Range National Park, *K.R. Thiele 5223* (PERTH); D: Onslow (not vouchered). Photographs by R.L. Barrett (A, B); K.R. Thiele (C); Department of Biodiversity, Conservation and Attractions (D).

**Distribution:** From Port Headland south to Shark Bay, inland to Newman in Western Australia (Fig. 7).

**Habitat:** Grows on sandy dunes or flats and sandy clay or loam soils, in river channels, or sometimes on beach sand, in shrubland, tussock grassland or hummock grassland with *Acacia coriacea*, *A. murrayana*, *A. sclerosperma*, *A. tetragonophylla*, *A. trachycarpa*, *Atalaya hemiglauca*, *Brachycome latisquamea*, *Chorizema racemosum*, *Eremophila subfloccosa*, *Eucalyptus camaldulensis* subsp. *refulgens*, *Eulalia aurea*, *Exocarpos*

*sparteus*, *Grevillea gordoniana*, *Hakea lorea* subsp. *lorea*, *Quoya loxocarpa*, *Rhagodia preissii*, *Rhynchosia minima*, *Santalum lanceolatum*, *Triodia basedowii*, and *T. epactia*.

**Phenology:** Flowers mostly June–August.

**Conservation status:** *Corynotheca pungens* is widespread and is not currently considered threatened.

**Common name:** Spiny Sand Lily.

**Etymology:** The specific epithet is from the Latin *pungens* (sharp, piercing), in reference to the sharp lower bract apices.

**Affinities:** *Corynotheca pungens* is a distinctive species of uncertain affinity, but it may be most closely related to *C. licrota* with which it shares long, persistent leaves and long racemes with many nodes that are  $\pm$ straight. The bracts of *C. licrota* are acuminate and sharp, but not pungent as in *C. pungens*. *Corynotheca pungens* differs in having a spreading (*vs* erect) habit, fleshy-fibrous (*vs* fibrous) roots, mostly cauline (*vs* mostly basal) leaves, slender leaves 0.5–2 (*vs* 2.5–4.1(–9)) mm wide, more divergent panicle branches 90–150° (*vs* 130–160°), smaller seeds 2.7–2.9 (*vs* 3.0–4.3) mm long with fused, colliculate (*vs* free and folded) caruncle lobes.

**Notes:** Gauba (1948) included a few specimens of this taxon under his concept of the taxon here recognised as *C. licrota* (treated there as *Corynotheca lateriflora* var. *laevisperma*).

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