

Three new species of *Zygophyllum* (Zygophyllaceae) from Namibia and Northern Cape, South Africa

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ABSTRACT

Three new species of *Zygophyllum* L. from the lower Orange River area in Namibia and Northern Cape, South Africa are described, namely, *Z. applanatum* Van Zyl, *Z. hirticaule* Van Zyl and *Z. pterocaule* Van Zyl.

INTRODUCTION

Since the publications of Sonder (1860), Van Huyssteen (1937) and Schreiber (1963), several new species of *Zygophyllum* have come to light. Most of them were found in the lower Orange River basin forming part of the northern zone of the winter rainfall area of the arid Karoo-Namib region of southern Africa. When dealing with taxa in this area, Nordenstam (1966) suggested the term 'Gariiep element' for these extreme xerophytic species that constitute a significant phytogeographical group. Cowling & Hilton-Taylor (1997) considered the Gariiep area, falling within the Succulent Karoo Biome, as one of the centres of exceptional species endemism in southern Africa. El Hadidi (1978) considered the arid zones of Namibia and South Africa, including the Gariiep element, to be of importance as a second centre of origin for taxa belonging to Zygophyllaceae, native to the Old World.

The genus *Zygophyllum* is well represented in the Gariiep element, with seven out of the 18 Namibian species recognised by Schreiber (1963), occurring there. Recent discoveries add another nine new species of *Zygophyllum* to Schreiber's list, all occurring in the Gariiep area. In this paper, three of these new species of *Zygophyllum* are described.

Zygophyllum applanatum Van Zyl was first collected by Dinter during 1922–1929, after which this tiny, but locally abundant plant, was missed by other collectors until recently. He recognised it as a new species and used the *nom. nud.* 'adpressum' on herbarium sheet *Dinter 6614* (BOL), whereas Schreiber (1963) considered this sheet to be a hybrid between *Z. clavatum* Schltr. & Diels and another *Zygophyllum* species with longer capsules. Subsequent collections and field observations made by me convinced me that *Z. applanatum* is a new species. *Z. hirticaule* Van Zyl was discovered by Oliver & Muller in 1976 and *Z. pterocaule* Van Zyl was first collected by Muller in 1977. Both *Z. applanatum* and *Z. pterocaule* belong to the subgenus *Agrophyllum* Endl. section *Bipartita* Huysst., with divided staminal scales as an

important characteristic, whereas *Z. hirticaule* belongs to the subgenus *Zygophyllotypus* Huysst. section *Capensia* Engl., with undivided staminal scales.

Young stems of *Zygophyllum* species display taxonomically useful characteristics in cross section. In § *Capensia*, internodes are often ventrally flattened, with or without lateral ridges, whereas § *Alata* is characterised by a distinct ventral groove (Van Zyl & Marais 1997). In § *Bipartita* the young stems of a few species are winged in a dorsiventral plane, usually with a single ventral wing. *Z. pterocaule* displays both a dorsal and ventral wing. Figure 1.

***Zygophyllum pterocaule* Van Zyl, sp. nov.** (§ *Bipartita*), *Z. prismatocarpo* Sond. affinis sed fruticulus decumbens ramulis dorsiventraliter alatis. Figura 2.

Fruticulus decumbens, ad 0.15 m altus, ± 0.8 m diametro. *Ramuli* alis duobus plano dorso ventrali. *Folia* opposita, sessilia, simplicia, orbiculata, articulata, amplitudine diminuentia apicem versus. *Sepalum* externum succulentum, cucullatum. *Petala* spathulata, alba. *Discus* 5-lobatus, lobis indentatus. *Stamina* 10. *Squama* staminalis bipartitae, ovatae vel ellipticae, marginem integri. *Ovarium* cylindricum, 5-lobatum. *Fructus* capsula septicida, viva succulenta, 5-lobata, mollis; desiccata 5-angulata, 9 × 6 mm. *Semina* multa, fusca, pyriformia, 2 × 1 mm, quam funiculis longiora, tecta madida mucum sine structura procreans.

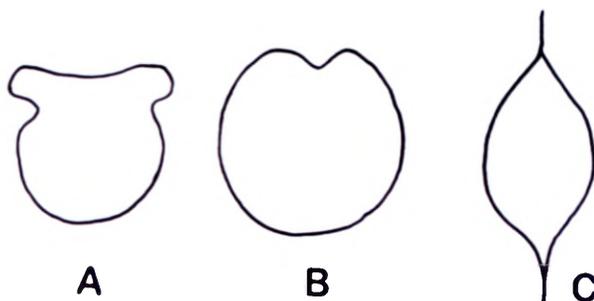


FIGURE 1.—Section through internodes. A. *Zygophyllum fuscatum*, Van Zyl 4293 (§ *Capensia*); B. *Z. suffruticosum* Schinz, Van Zyl 3809 (§ *Alata*); C. *Z. pterocaule* Van Zyl, Van Zyl 4478 (§ *Bipartita*).

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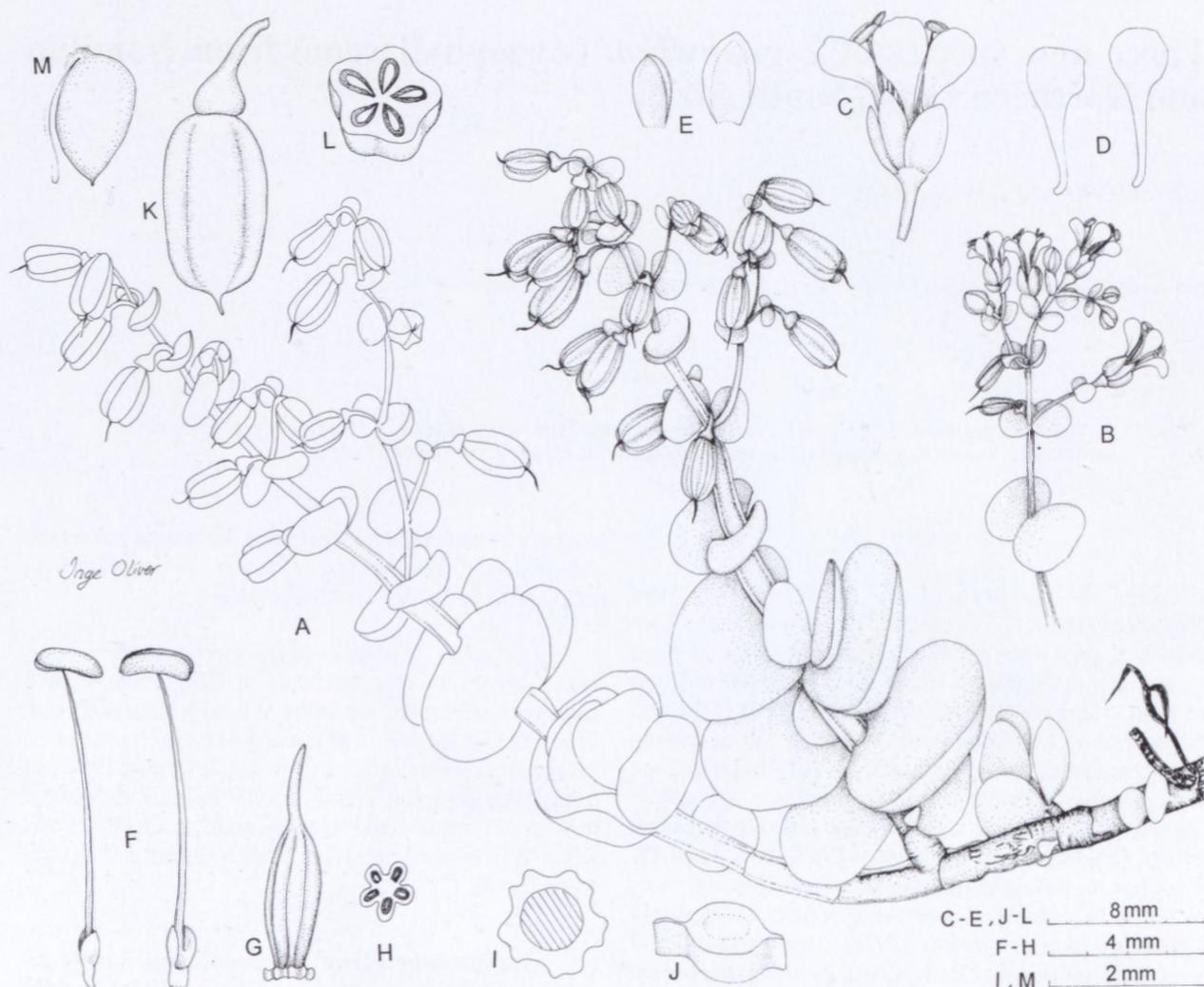


FIGURE 2.—*Zygophyllum pterocaule*, Van Zyl 4478. A, fruiting branch, life size; B, flowering branch, life size; C, side view of flower; D, petals; E, sepals; F, stamens with staminal scale, side and ventral view; G, ovary; H, section of ovary; I, section of nectar disc; J, section of internode; K, fresh capsule; L, section of fresh capsule; M, immature seed. Scale bars: C–E, J–L, 8 mm; F–H, 4 mm; I, M, 2 mm. Artist: Inge Oliver.

TYPE.—Northern Cape: Cornellskop, west of Khusbus, Richtersveld, (–BD), Van Zyl 4136 (NBG, holo.; B, PRE, S, WIND).

Decumbent, succulent, branched shrublet up to 0.15 m high and 0.8 m diam. *Stems*: old stems woody, brown, with swollen nodes and rough textured bark; young branches grey, smooth, internodes visible and with two prominent wings in a dorsiventral plane (Figure 1C). *Leaves* opposite, sessile, simple, glaucous; lamina articulate, suborbicular, succulent, 20–30 × 20–30 mm, gradually reduced in size towards branch apex; stipules filamentous, caducous, vestigial. *Flowers* solitary or two together, axillary; pedicel 4–9 mm long. *Sepals* 5, suborbicular to obovate, outer 3 succulent with scarios margins, cuculate, articulate, 4.0–5.5 × 2.0–3.5 mm. *Petals* 5, spatulate, 7.0–9.5 × 2.5–3.0 mm, white, margins sometimes undulate. *Nectar disc* fleshy, smooth, 10-lobed; lobes arranged in 5 pairs, orientated downwards, each pair with a raised central area and with a sunken area between pairs, disc has a hole sloped towards its periphery. *Stamens* 10; filaments terete, 6–7 mm long; staminal scales bilobed, segments ovate to elliptic, margins entire, 1.5–0.7 mm, $\pm \frac{1}{5}$ as long as filament. *Ovary* cylindrical, 5-lobed; style terete; stigma simple. *Fruit* a septicidal capsule: when fresh, succu-

lent, drooping, 5-lobed, cylindrical, interocular areas filled with a sticky juice, 9–6 mm; when dried, somewhat shrunken in size, prominently 5-angular, each locule containing up to 10 seeds which are glued to the walls. *Seed* pyriform, 2 × 1 mm, brown, attached with a long funicula; testa granular, hyalinous, producing structureless mucilage when wet. Figure 2.

Diagnostic characters

The most prominent features of *Zygophyllum pterocaule* are the suborbicular, simple leaves and young stems with two wings (hence the specific epithet which is Greek for winged stem). It is allied to *Z. prismatocarpum* Sond., also in section *Bipartita*, with regard to leaf and floral morphology, but differs in habit. *Z. pterocaule* has a decumbent habit, reaching a height of only 0.15 m, whereas *Z. prismatocarpum* is an erect shrub of up to 1.0 m or more and has only one wing on its young stems.

Sterile *Z. pterocaule* could also be confused with *Z. cordifolium* L.f. (§ *Paradoxa*, subgenus *Zygophyllotypus*) because of simple, suborbicular leaves and a decumbent habit, but the presence of the two wings on

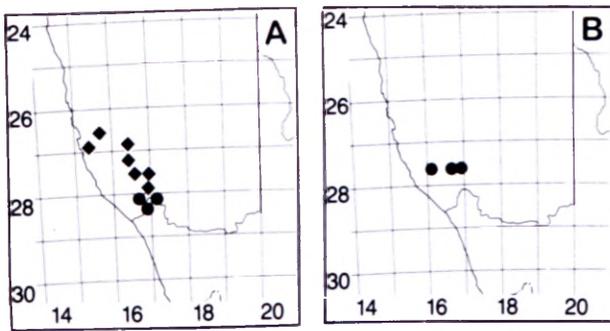


FIGURE 3.—Distribution of *Zygophyllum*. A. *Z. pterocaulum* Van Zyl, ●, and *Z. applanatum* Van Zyl, ◆. B. *Z. hirticaule* Van Zyl, ●.

the stems of the former species should, however, prevent confusion. The distribution of these two species sometimes overlap. When flowering, the small, 10 mm long, white flowers of *Z. pterocaulum* should easily be distinguished from the larger, 14–18 mm long, prominently marked, yellow flowers of *Z. cordifolium*.

Distribution and habitat

Z. pterocaulum has a limited distribution in the lower Orange River basin (Figure 3A). On the Namibian side, collections were made at the Schakalsberge and between the confluence of the Boom and Dabimub Rivers with the Orange River. Collections were also made on Cornellskop and at Annisfontein, to the western side of the Richtersveld National Park in the Northern Cape. The vegetation on the South African side of the distribution area is classified by Hoffman (1996) as Lowland Succulent Karoo, occurring below the escarpment on rich soils derived from granite and gneiss, representing an extremely arid vegetation type. The dominant plants are dwarf shrubs belonging to the Mesembryanthemaceae. Rainfall varies from 50–200 mm annually during the winter months and summers are hot and dry. Irish (1994) describes the vegetation on the Namibian side as Namibian Succulent Karoo, characterised by chamaephytic dominance and a much lower rainfall than the Succulent Karoo of South Africa.

Plants of this species were observed growing on limestone-rich, stony soils, on slight slopes and in dry stream beds, always in association with other *Zygophyllum* species. No shedding of leaves was observed possibly because, in this case, the leaves are succulent and serve as storage organs for water. Flowering occurs from July to October while shedding of ripe seeds occurs months later. Ripening of fruits and seeds of *Z. pterocaulum* takes longer than most other species in this genus because of the very succulent nature of the fruit. Although no grazing damage to this species was observed, the small size of populations and the absence of seedlings or young plants were noticeable and therefore this species could be considered as vulnerable.

Specimens examined

NAMIBIA.—2816 (Oranjemund): Schakalsberge, in dry stream bed, (–BA). Muller 768 (PRE, WIND); 2817 (Vioolsdrif): between Boom and Dabimub Rivers along Orange River, (–AA). Van Zyl 4478, (NBG,

WIND).

NORTHERN CAPE.—2816 (Oranjemund): Annisfontein, Richtersveld, (–BD), Jurgens 22160 (PRE); north of Annisfontein, Richtersveld, (–BD), Pillans 5005 (K); Cornellskop, Richtersveld, (–BD). Van Jaarsveld, Forrester & Jacobs 8584 (NBG, PRE); Van Zyl 4064 (NBG, PRE), 4136 (B, NBG, PRE, S, WIND).

***Zygophyllum applanatum* Van Zyl, sp. nov.**, (§ *Bipartita*), *Z. clavatum* Schltr. & Diels affinis sed fructibus prostratus, fructibus cylindricis, Figura 4.

Fruticulus prostratus. Rami albi, coriacei, ramuli ventraliter debiliter sulcati. Folia opposita, bifoliata, petiolata, ramulis floriferis unifoliata vel sessilia, foliola subrotunda, articulata. Sepala exteriora succulenta, cucullata. Petala spathulata, alba. Discus 5-lobatus, lobis indentatis. Squamae staminales bipartitae, longitudine $\frac{1}{2}$ filamentorum partes aequantes. Ovarium cylindricum. Fructus capsula septicida, seminibus multis, viva cylindrica, desiccata 5-angulata. Semina pyriforma, quam funiculis longiora, tecta madida mucum sine structura procreans.

TYPE.—Namibia, 2615 (Luderitz): Haalenberg, E of Luderitz, (–DA), Van Zyl 3865 (NBG, holo.; B, PRE, S, WIND).

Small, semiprostrate shrublet, branched from base, up to 0.2 m diam., mostly quite prostrate but after good rains resprouting from centre, reaching a height of 100 mm. Stems: old stems white, coriaceous, horizontal, up to 100 mm long; young branches greenish brown, round to elliptical in section with a poorly developed ventral groove. Leaves opposite, petiolate, glaucous, bifoliolate, on flowering branches gradually reduced to a unifoliolate, sessile state; leaflets articulate, subrotund, slightly fleshy, 4–7 × 4–7 mm, base sometimes cuneate; petiole articulate, cylindrical, 1–3 mm long; stipules membranous, caducous, reddish brown, triangular, apex sometimes incised, 0.5 × 2.0 mm. Flowers solitary, axillary; pedicel 1–3 mm long. Sepals 5, ovate to elliptic, outer 3 succulent, cucullate, 2.0–3.5 × 1.0–1.5 mm. Petals 5, spathulate, 3.0–4.0 × 1.5 mm, apex acute or rounded, base long-clawed, white. Nectar disc fleshy, granular, 5-lobed, each lobe indented. Stamens 10; filaments terete, 2–4 mm; staminal scales 10, bipartite, ovate to elliptic, segments oblong, apex somewhat acute, base narrowed, margins entire, 1.3–1.8 × 0.4–1.0 mm, ± half as long as filament. Ovary cylindrical, covered with translucent globules; style terete, short; stigma simple. Fruit a septicidal capsule: when fresh, succulent, drooping, cylindrical with faintly visible sutures; when dried somewhat shrunken in size, 5-angled, cylindrical, 12 × 4 mm. Seed pyriform, 1–8 per locule, 1.5 × 0.6 mm, light brown, long funicle present, testa granular, hyaline, producing structureless mucilage when wet. Figure 4.

Diagnostic characters

Zygophyllum applanatum is closely allied to *Z. clavatum* Schltr. & Diels with regard to leaf and floral characters but is readily distinguishable by its fruits and habit. *Z. clavatum* has an erect habit, up to 500 mm high, whereas *Z. applanatum* grows horizontally (hence the specific epi-

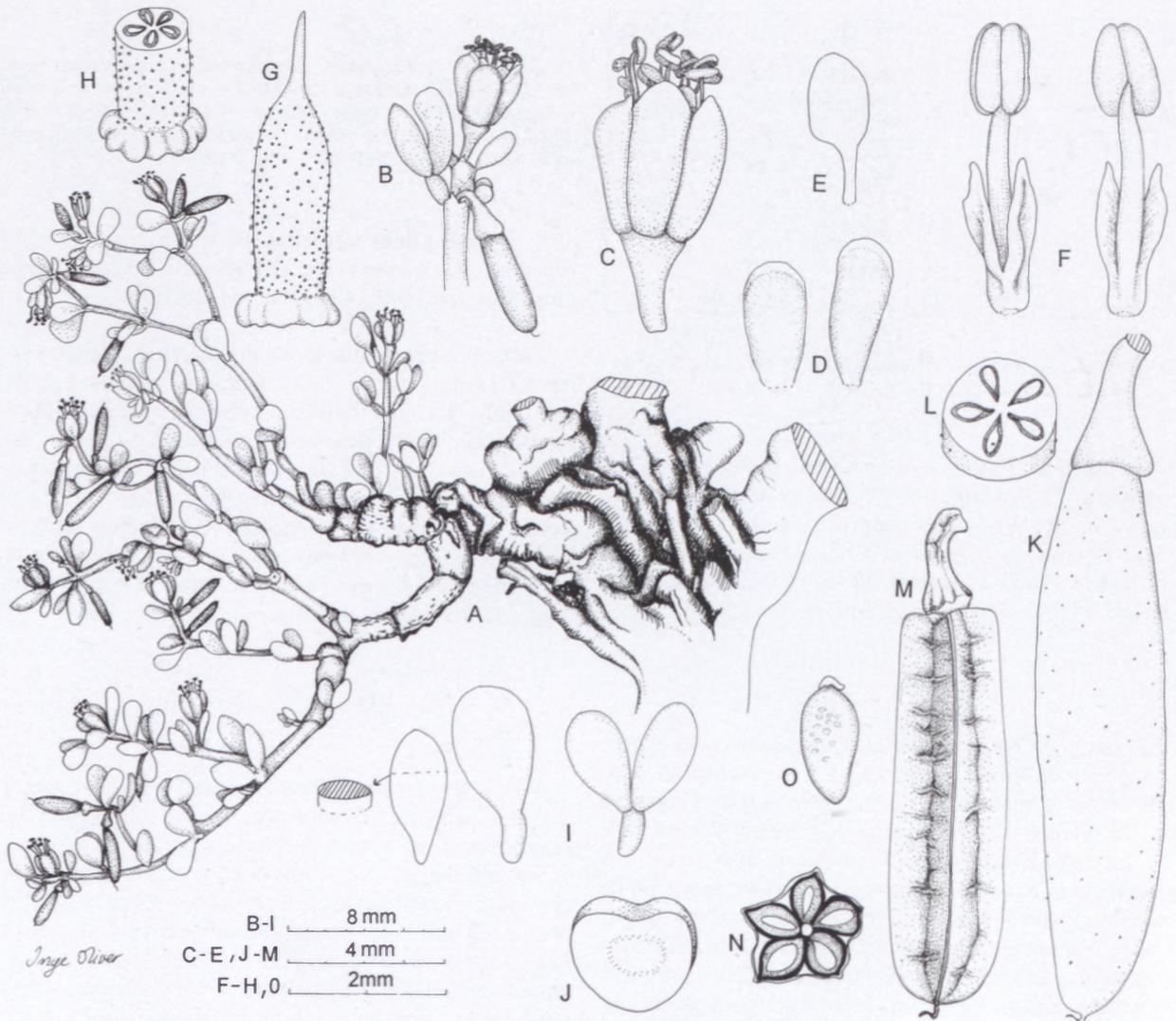


FIGURE 4.—*Zygothymus applanatum*, Van Zyl 4482. A, flowering and fruiting branch, life size; B, twig with flower, leaf and young fruit; C, side-view of flower; D, sepals; E, petal; F, stamens with staminal scale, dorsal and ventral side; G, ovary; H, section of ovary; I, range of leaves plus section; J, section of internode; K, fresh fruit; L, section of fresh fruit; M, dried fruit; N, section of dried fruit; O, seed. Scale bars: B–I, 8 mm; C–E, J–M, 4 mm; F–H, O, 2 mm. Artist: Inge Oliver.

thet which is Latin for flattened or horizontally expanded). During exceptionally good rainfall seasons *Z. applanatum* can grow to 100 mm high by resprouting from the centre, so displaying an atypical habit. Unfortunately the illustration (Figure 4), depicting this taxon was done from atypical material, giving a false impression of the habit. A photograph which was taken during an ordinary rainfall season (Figure 5), is included to remedy this. Both taxa have septicial capsules but they differ in shape. Dried fruits of *Z. applanatum* are cylindrical, 5-angled and up to 12×4 mm, whereas those of *Z. clavatum* are wider than long, 5-partite, 2.5×4.0 mm. *Z. applanatum* with its limited distribution is restricted to the winter rainfall area, whereas *Z. clavatum* occurs in a much larger area with both winter and summer rainfall, sometimes overlapping with the former species.

Distribution and habitat

Zygothymus applanatum is found in a small area in the southern part of Namibia. Several collections were made around Luderitz, south of Aus and towards

Witputz and Rosh Pinah (Figure 3A). The vegetation in this area is classified as Succulent Karoo Biome dominated by chamaephytes (Irish 1994). Rainfall occurs during winter with occasional light snowfalls around Aus. Average annual precipitation varies from 40–90 mm, which is lower than the similar Succulent Karoo Biome in South Africa. Summers are hot and dry with frequent periods of drought. In the restricted areas belonging to the mining groups and where little or no farming activity occurs, populations consisting of hundreds of plants, including many seedlings and young plants, were observed growing on chalky, desert flats often in association with other *Zygothymus* species. *Z. applanatum* appears to be edible because in the sheep farming areas around Aus, plants were nearly absent inside grazing camps, whereas on the road shoulders they were common. Leafless plants were observed during dry periods and it can be assumed that leaf shedding occurs as a survival strategy during droughts. Flowering and fruiting were recorded during August to December. The succulent nature of the fruits causes a delay in shedding of ripe seeds and this usually occurs only months after flowering.



FIGURE 5.—*Zygophyllum applanatum* Van Zyl. Photo taken during a normal rainfall season.

Specimens examined

NAMIBIA.—2615 (Luderitz): hills E of Grillenthal, S of Luderitz, (–CD), Van Zyl 3879 (NBG, PRE, WIND); 14 km S of Grasplatz, towards Grillenthal, (–CD), Van Zyl 3868 (NBG, PRE); Haalenberg, E of Luderitz, (–DA), Van Zyl 3865 (B, NBG, PRE, S); Dinter 6614 (B, BOL, Z). 2616 (Aus): Kubub 15, Tsamvlakte, S of Aus, (–CD), Van Zyl 3881 (NBG, PRE). 2716 (Witputz): Arutal 25, 28 km S of Aus, (–AB), Van Zyl 3886 (B, NBG); Pochenbank 68, 70 km S of Aus, (–AB), Van Zyl 3891a (NBG); Kuckaus, (–AB), Dinter 3724 (B); Nord Witputz 22, 55 km N of Rosh Pinah, (–DA), Van Zyl 3896b (NBG); Witputz, (–DA), Dinter 8078a (B); Arimas 83, NE of Rosh Pinah, (–DB), Van Zyl 4482 (NBG, PRE, WIND); plains at entrance to Rosh Pinah, (–DD), Van Zyl 4470 (B, NBG, PRE, S, WIND).

***Zygophyllum hirticaule* Van Zyl, sp. nov.**, (§ *Capensia*), suffrutex multicaulis, a speciebuis aliis sectionis ramulis pedunculisque hirsutis, fructo rubiginoso, alato tomentosoque distinguitur. Figura 6.

Suffrutex multicaulis. Rami eburnei, ramuli hirsuti; internodia rotunda vel ventraliter complanata, sine costata. Folia sessilia; foliola glauca, obovata. Squama staminales simplices, ellipticae, margine et superficiebus ambatus in dimidio superiore papillatae, tomentosum, apice retuso. Fructus capsula loculicida, rubiginosa, oblonga, 5-angulata, lateribus tomentosis, alisque angustis, glabrescentibus. Semina arillo albo, testa madida mucum contentis prominentibus spiralibus procreans.

TYPE.—Namibia, 2716 (Witputz): Nord Witputz 22, 55 km N of Rosh Pinah, (–CB), Van Zyl 3894 (NBG, holo.; B, PRE, S, WIND).

Compact shrublet, branched from base, up to 0.3 m high and 0.5 m diam. *Stems*: old stems glabrous with swollen nodes and ivory-coloured bark; young stems hirsute, round in section or ventrally flattened but without lateral ridges. *Leaves* opposite, sessile, bifoliolate, glaucous when fresh, when dried, leathery in texture and displaying numerous, embedded crystals resulting in an uneven, warty texture, glabrous to glabrescent on margins and at base; leaflets articulate, asymmetrical, obovate, 20–40(47) × 13–25(34) mm, apex rounded, base mostly cuneate; stipules fleshy, caducous, triangular or

subrotund, margins fringed, tomentose on dorsal side, one on ventral side and one on dorsal side of stem, 2–3 × 3–6 mm. *Flowers* solitary or two together, axillary; pedicel densely hirsute, up to 20 mm long. *Sepals* 5, ovate, tomentose on dorsal side, green, changing to burgundy when dry, persistent, 8 × 4–5 mm. *Petals* 5, patent, elliptic to obovate, 10–13 × 5–8 mm, apex rounded or acuminate, base with short claw, pale yellow. *Nectar disc* fleshy, papillose, 10-angled. *Stamens* 10; filaments terete, 7–8 mm long; staminal scales 10, simple, oblong with a slightly rounded apex, margin and upper half of both surfaces papillate, 3.5–4.0 × 1.5 mm, ± 1/2 as long as filament. *Ovary* oblong, 5-angled, tomentose with 5 glabrous wings, apex retuse; style terete; stigma simple. *Fruit* a loculicidal capsule with ± same shape when fresh or when dried; oblong, 5-angled and 5-winged, with reddish, tomentose sides and narrow, glabrescent wings, 13–17 × 11–13 mm. *Seed* oblong, in 2–3-seeded loculi, 4 × 2 mm, brown with a white aril, testa smooth, translucent, producing brown mucilage with prominent spiral inclusions when wet.

Diagnostic characters

Zygophyllum hirticaule is distinguished by its hirsute young branches and pedicels (hence the specific epithet which is Latin for hairy stems) and by the reddish, tomentose capsule with narrow, glabrous wings. These fruits resemble those of *Z. debile* Cham. in colour and shape but in the latter the indumentum is lacking. These two species occupy completely different distribution ranges. *Z. hirticaule* stands somewhat on its own within section *Capensia* and has no close affinities with others in the group.

Distribution and habitat

Z. hirticaule is found in the southwestern part of Namibia (Figure 3B). Collections were made around Witputz and Kolke, N of Rosh Pinah. Irish (1994) classifies the vegetation in this area as Succulent Karoo Biome characterised by chamaephytic dominance. Summers are hot and dry with frequent periods of drought. Rainfall

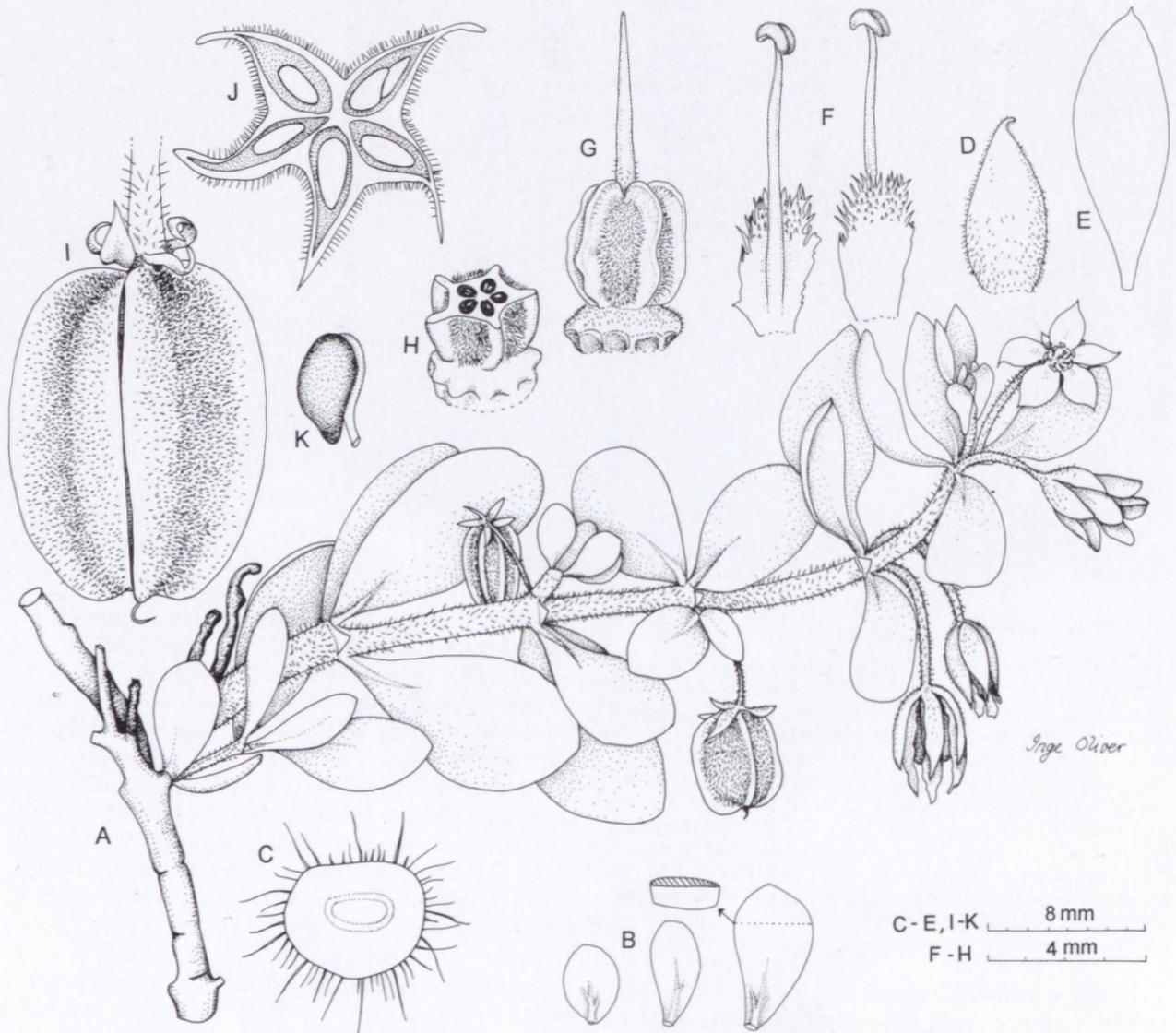


FIGURE 6.—*Zygophyllum hirticaule*. A–H, Van Zyl 4480; I, J, Van Zyl 3902. A, flowering and fruiting branch, life size; B, range of leaves plus section, half size; C, section of internode; D, sepal; E, petal; F, stamens with staminal scale, dorsal and ventral side; G, ovary; H, section of ovary; I, dried fruit, $\times 3$; J, section of dried fruit, $\times 3$; K, seed. Scale bars: C–E, I–K, 8 mm; F–H, 4 mm. Artist: Inge Oliver.

occurs during winter months with a yearly average ranging between 40 and 90 mm. Large populations were seen, including many seedlings and juveniles, growing on sparsely vegetated, stony, desert flats of a dolomitic and doleritic nature. A survival strategy, like so many species of this genus, seems to be the ability to shed leaves during periods of water stress. The remaining ivory-coloured stems of the leafless plants appear lifeless, but after the first rains they 'come alive' with leaves. Little evidence of grazing was seen and as farming activities in this area do not include ploughing, this species is at present under no threat. A specimen much resembling this species, but totally glabrous, was collected at Delphin kopf, Spencer Bay (*Giess & Robinson 13206*, WIND). This locality falls within a restricted mining area and in sandy desert terrain. For a final opinion on this specimen, better field observation and more collections are necessary.

Specimens examined

NAMIBIA.—2716 (Witputz): Aurusberg, NW of Rosh Pinah, (–CA), *Muller 740* (WIND); Witputz Nord 22, 55 km N of Rosh Pinah, (–DA),

Van Zyl 3894 (B, NBG, PRE, S, WIND); Witputz Sud 31, N of Rosh Pinah, (–DA), *Van Zyl 3902* (NBG, PRE, WIND); *Oliver & Muller 6406* (PRE); *Kolke 84*, N of Rosh Pinah, (–DB), *Van Zyl 4480* (NBG, WIND).

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