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Two new species of *Stylochaeton* (Araceae: Aroideae) from South Africa

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Abstract

We are describing here *Stylochaeton glaucophyllum* and *S. sekhukhuniense*, two new species from northeastern South Africa. Both species have a restricted distribution and are endemic to the Sekhukhuneland Centre of Plant Endemism, Limpopo and Mpumalanga Provinces, South Africa. The new species occur sympatrically with *S. natalense*, but never with one another. *Stylochaeton glaucophyllum* prefers norite and pyroxenite hills and mountains, whereas *S. sekhukhuniense* is associated with similar rock types in low-lying rocky areas. Both new species have the base of the spadix and infructescence partly below-ground and are mainly associated with open savannah. *Stylochaeton glaucophyllum* can be distinguished from *S. sekhukhuniense* in having greenish blue leaves with linear lobes while *S. sekhukhuniense* has green leaves with elliptic lobes. The leaves of *S. glaucophyllum* are longer (112–332 mm) than those of *S. sekhukhuniense* (44–180 mm). The petiolar sheath of *S. sekhukhuniense* extends into two slender, curling ligulae which are absent in *S. glaucophyllum.* Also included here is a key to the seven currently accepted species of *Stylochaeton* in southern Africa (South Africa, Eswatini, Zimbabwe and Mozambique).

Key words: bushveld arum, endangered, geocarpy, Sekhukhuneland Centre of Endemism, serpentine, Stylochaetoneae, taxonomy, ultramafic soil, Zamioculcadoideae

Introduction

The Sekhukhuneland Centre of Endemism is a biogeographical region located about 200 km northeast of Pretoria in the Limpopo and Mpumalanga provinces of South Africa. It is bordered in the north by the Strydpoort Mountains, in the east by the Steenkampsberg and Great Escarpment, in the west by the Springbok Flats and in the south by the Highveld Escarpment (Van Wyk & Smith 2001). The Sekhukhuneland region has a high number of endemic plant species that occur within a small geographic area (Siebert *et al*. 2001). Following its recognition as a local centre of endemism (Van Wyk & Smith 2001), increasing botanical exploration of this area has resulted in the discovery of many species new to science, and since 2000, 15 plant species endemic to the Centre have been described with the latest addition being *Gymnosporia sekhukhuniensis* Jordaan & Van Wyk (2019: 72). In recent years the Sekhukhuneland Centre has also proved noteworthy in terms of new ant species (Hawkes 2018).

In South Africa, a single described species of *Stylochaeton* Leprieur (1834: 184) is currently recognized (Germishuizen 2006), namely *S. natalense* (as "*natalensis*") Schott (1855: 10, t14) (Fig. 1). It is found in the northeastern regions of South Africa (Northwest, Gauteng, Limpopo, Mpumalanga, and KwaZulu-Natal) (Manning 2019). Its distribution extends into Eswatini, Mozambique and further north in Africa through Zimbabwe to Malawi and Tanzania (POWO 2023). *Stylochaeton natalense* (Fig. 1) is also a prominent element of the subtropical savannah vegetation of the Sekhukhuneland region (Siebert *et al*. 2002).

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FIGURE 1. *Stylochaeton natalense*, general morphology. **A.** Plants with ca. sagittate leaves. **B.** Inflorescence. **C.** Plants with ca. hastate leaves. **D.** Developing infructescence. Photographs: W. McCleland (A), R.G.C. Boon (B), G. Nichols (C) and A.E. van Wyk (D).

Stylochaeton is a genus of about 20 species (POWO, 2023) traditionally classified in Araceae, subfamily Aroideae (Nicolson & Mayo 1984), proposed to be transferred to subfamily Zamioculcadoideae (Bogner & Hesse 2005, Henriquez *et al*. 2014, Abdullah *et al*. 2020). The genus is restricted to and distributed across tropical and southeastern subtropical Africa in savannah and humid deciduous forests (Mayo *et al*. 1997).

Members of *Stylochaeton* are geophytes with a slender rhizome and often heavily swollen fleshy roots. Typical for the Araceae family, the genus has a spadix as an inflorescence, comprising a thickened, fleshy axis (spike) bearing clusters of sessile, unisexual flowers. The small flowers are packed together along the erect spike, typically with male flowers above the female ones. Male (staminate) flowers consist of numerous threadlike stamens packed together, while female (pistillate) flowers consist of numerous individual pistils enclosed by a tubular perigone with protruding styles. The spadix emerges from a vase-shaped modified leaf (spathe) with its base fully closed (Mayo *et al*. 1997).

During various ecological surveys in the Sekhukhuneland region, divergent populations of two morphologically different *Stylochaeton* entities came to our attention, both occurring sympatrically with *S. natalense* (Fig. 1). Mature leaf morphology of these divergent populations resembled that of juvenile individuals of *S. natalense*, hence they were initially identified as such. A survey of metal-accumulating plants (Adhikari *et al.* 2022), which began in the mid-1990s, prompted a taxonomic study of these divergent plants. This was due to the discovery that some of these plants, excavated for analysis, revealed underground reproductive structures (geocarpy), a feature absent in *S. natalense*. Subsequent more detailed observations confirmed that these divergent populations represented two undescribed species. The resemblance of the leaves to juvenile leaves of *S. natalense*, along with the presence of subterranean inflorescences/fruits, likely contributed to the historical oversight of these two new species.

The aim of this paper is to formally describe the two new species of *Stylochaeton* from Sekhukhuneland as *S. glaucophyllum* and *S. sekhukhuniense*. This increases the number of species in the genus to three in South Africa and seven in southern Africa (South Africa, Eswatini, Zimbabwe and Mozambique; hitherto no members of the genus have been recorded in Lesotho, Botswana and Namibia). The description of the two new species also raises the number of Aroideae endemics in Sekhukhuneland to four, the other two being the golden arums, *Zantedeschia jucunda* Letty (1961: 455) and *Z. pentlandii* (R.Whyte ex Watson 1892: 123) Wittmack (1898: 593). Focus is placed on vegetative characters that are known as taxonomically significant for the demarcation of infrageneric taxa in *Stylochaeton*. An identification key to the species of *Stylochaeton* in southern Africa is also provided. This contribution emanates from an ongoing project to study the flora and vegetation of the Sekhukhuneland Centre of Endemism.

Materials and methods

Field observations, comparative morphology, and mapping

Descriptions and observations reported here are based on observations of the species in their natural habitat, combined with field knowledge gained by studying plant diversity patterns in Sekhukhuneland over many years. As the inflorescences were cryptic, we had to place markers during summer when plants were in leaf in order to readily locate the flowers in spring when the plants are leafless, with any remains of old dried leaves often removed by the frequent wild fires. Morphological data were gathered during field trips, and from herbarium specimens and material preserved in formalin-acetic acid-alcohol (FAA) (Johansen 1940) that was obtained from the H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria, Pretoria, and the A.P. Goossens Herbarium (PUC), North-West University, Potchefstroom (herbarium abbreviations as per Thiers 2023). Locality information for specimens cited also provides the particular quarter degree grid squares following the degree reference system of Edwards & Leistner (1971). The distribution maps were compiled from specimen data using ArcGIS software. The original base map is based on the GTOPO30 global digital elevation model, and colours were modified in Global Mapper v6.06. The threat status assessment follows the standard procedures based on IUCN guidelines (IUCN 2012) and geospatial analyses with GeoCAT (Geospatial Conservation Assessment Tool; Bachman *et al*. 2011).

Soil analyses

Soil and leaf material of three populations of each new species of *Stylochaeton* were collected to determine any soil-plant associations. Leaves from five individual plants and associated soil at the root level were collected at each population, and all 15 collections per species were made into composite samples. The two composite leaf samples were washed with deionized water and a 0.1 molar hydrochloric acid solution for 1 min and rinsed with distilled water three times. Soils were sieved (2 mm) to remove rocks and organic material and ground to < 75 µm using a tungsten carbide ring mill, then were oven-dried for 48 h at 60 °C. Twenty-five grams of material from each composite plant and soil samples from each treatment were digested in a 15 ml nitric acid solution and transferred to a sand stove set at 95 ºC while digestion occurred. Samples were cooled and 3 ml of a 30% hydrogen peroxide solution was added. After cooling, 10 ml of a 3N HCl solution was added and covered with a watch glass. The mixture was left to reflux for an hour until cooling down to 25 ºC. The mixture was then filtered through filter paper into a 50 ml volumetric flask. The volumetric flask was filled to volume with deionized water and proceeded to the analysis of trace metal elements in an inductively coupled plasma mass spectrometer (Agilent 7500 series), calibrated with a certified multi-element standard solution (PerkenElmer Pure). Soil pH was estimated via 1:2.5 extraction and EC (electrical conductivity) and cation exchange capacity (CEC) was determined with a saturated extraction (NSSSA 1990).

Key to the species of *Stylochaeton* in southern Africa (Eswatini, Mozambique, South Africa and Zimbabwe)

1. Leaves with blade subcircular, adpressed to the soil surface ..... *S. europhyllum*
- Leaves with blade sagittate to cordate, erect, not adpressed to the soil 2
2. Leaves with blade oblong to triangular (broadly cordate, cordate-sagittate, subcordate), up to 300 mm wide..... 3
- Leaves with blade sagittate or hastate, up to 180 mm wide 5
3. Petiole up to 180 mm long; blade up to 160 mm long, apex ending in a cusp (0.7 mm long); spathe swollen at the base, followed by a constriction, swollen again above the constriction; male and female flowers separated by a naked axis ca. 19 mm long..... ..... *S. tortispathus*

- Petiole up to 430 mm long; blade up to 330 mm long, apex rounded, acute, acuminate or apiculate; spathe slightly inflated at the base only; male and female flowers separated by a naked axis ca. 1 mm long.....4
4. Leaf blade with basal lobes usually separated by a broad sinus; adaxial surface glabrous; inflorescence appearing with or after the leaves; spathe borne entirely above-ground, greenish to yellowish or purplish, limb straight when dry, female part cylindrical; infructescence borne above-ground..... *S. natalense*
- Leaf blade with basal lobes separated by a narrow sinus; adaxial surface pubescent, especially dense on the veins; inflorescence appearing before the leaves; spathe with base ca. subterranean, cream-coloured, limb twisted when dry; female part hemispherical; infructescence borne partly below-ground level ..... *S. puberulus*
5. Leaf blade with basal lobes shorter (ca. 25–64 mm) than apical lobe (ca. 64–152 mm) (sometimes as long as apical lobe); spadix with male and female flowers separated by a 2–12 mm zone of few to 10 sterile flowers; filaments somewhat to greatly thickened towards apex..... *S. borumense*
- Leaf blade with basal lobes (ca. 20–160 mm) and apical lobe (ca. 24–172 mm) of almost equal length; spadix with male and female flowers contiguous; filaments not thickened.....6
6. Leaf blade with basal and apical lobes linear, leathery, greenish blue; petiole glabrous; petiolar sheath narrowing gradually to apex but not ligulate; spadix projecting out from the spathe tube ..... *S. glaucophyllum*
- Leaf blade with basal and apical lobes elliptic, green; petiole with distal ⅓ above sheath often with scattered trichomes; petiolar sheath ligulate, extending distally into two slender, curling elongations (ligulae) up to 30 mm long; spadix enclosed in the spathe tube ..... *S. sekhukhuniense*

Taxonomic treatment

Stylochaeton glaucophyllum Struwig, S.J.Siebert & A.E.van Wyk, *sp. nov.* (Figs 2–5A)

In habit approaching forms of *S. borumense* with sagittate leaf blades, but differs in the spadix having male and female flowers contiguous and the filaments not thickened (*vs.* male and female flowers separated by a zone of few to 10 sterile flowers and filaments thickened towards apex). Morphologically most similar to *S. sekhukhuniense*, differing in having a glabrous petiole (*vs.* scattered trichomes on petiole immediate distal to petiolar sheath); petiolar sheath not ligulate (*vs.* distinctly ligulate); leaf blade long, 112–332 mm (*vs.* shorter, 44–180 mm) with basal and apical lobes linear (*vs.* elliptic), greenish blue (*vs.* green); spadix protruding somewhat from spathe-tube (*vs.* entirely enclosed by spathe-tube).

Type:—SOUTH AFRICA, Limpopo: Manyaka, Mashishi, ridge behind Makgamathu Secondary School, 2430AC, 5 December 1999, *Van Wyk & Siebert 1332* (holotype PRU!; isotypes PRE!, K!).

Geophyte, up to 450 mm high, with vertical rhizome, ca. 30 × 15 mm; roots stout, not tuberous. Cataphylls ca. 18–55 × 6–10 mm, membraneous, ensiform, acuminate with mucro ca. 2–4 mm long. *Leaves* usually 2–6; petiole 200–300 mm long, basal ⅓ covered with white and/or purple-green transverse bands/mottling, upper ⅔ green, glabrous throughout; petiolar sheath up to 85 mm long, with bands/mottling as described; blade narrow sagittate, apical lobe 58–172 × 5–27 mm, linear, mucro up to 15 mm long, basal lobes 54–160 × 4–20 mm, linear, tips rounded; greenish blue, glabrous, margin entire, veins prominent, 1 midvein with 2 principal lateral veins parallel to midvein, veins end in submarginal collective vein, coriaceous. *Inflorescence* appears before leaves; semi-subterranean; peduncle ca. 18–34 × 6–8 mm; spathe ca. 100–118 mm long, glabrous, thickened, inside (ventrally) creamish white, cream-coloured or pale buff (dull yellowish brown), rarely with dull vinaceous blotch in centre, outside (dorsally) brownish, yellowish brown or purplish brown, distinctly or vaguely longitudinally striped with creamish lines (veins), veins somewhat ribbed on outer surface; basal tube erect, 22–26 mm long, upper part cylindrical, 10–12 × 8–9 mm, lower part inflated, globose, ca. subterranean, 12–15 × 8–17 mm; upper limb 75–92 × 26–30 mm, oblong, acuminate, apex with cusp ca. 7 mm long. *Spadix* ca. 37 mm long, protrudes somewhat from spathe-tube; monoecious; staminate part cylindric, ca. 29 × 4 mm, many-flowered, contiguous with pistillate part, pistillate part hemispherical, ca. 8 × 9 mm, ≥ 10-flowered, flowers in 2 or 3 rows. *Staminate flowers* with perigone cupular, rhomboid, connate; stamens 4 or 5, filaments filiform, ca. 2 mm long; anthers globose, basifixed, extrorse; central pistillode lacking. *Pistillate flowers* with perigone cupular, contracted at the mouth, subregular, 4–6-sided, thickened, connate; stamens 0; ovary subglobose, 2-locular; style stout, ca. 2 mm long, exserted, stigma discoid, 1 mm broad. *Infructescence:* peduncle ca. 35 × 5 mm; globose, partially below the ground, 18–27 × 14–30 mm; a cluster of 10–25 berries, ripening white to yellowish or greenish cream, above-ground parts exposed to sunlight often with greenish to dark purplish brown surface, globose, 5–10 × 6–9 mm, styles persistent, 1 or 2-seeded. *Seeds* ovoid, ca. 4 mm long.

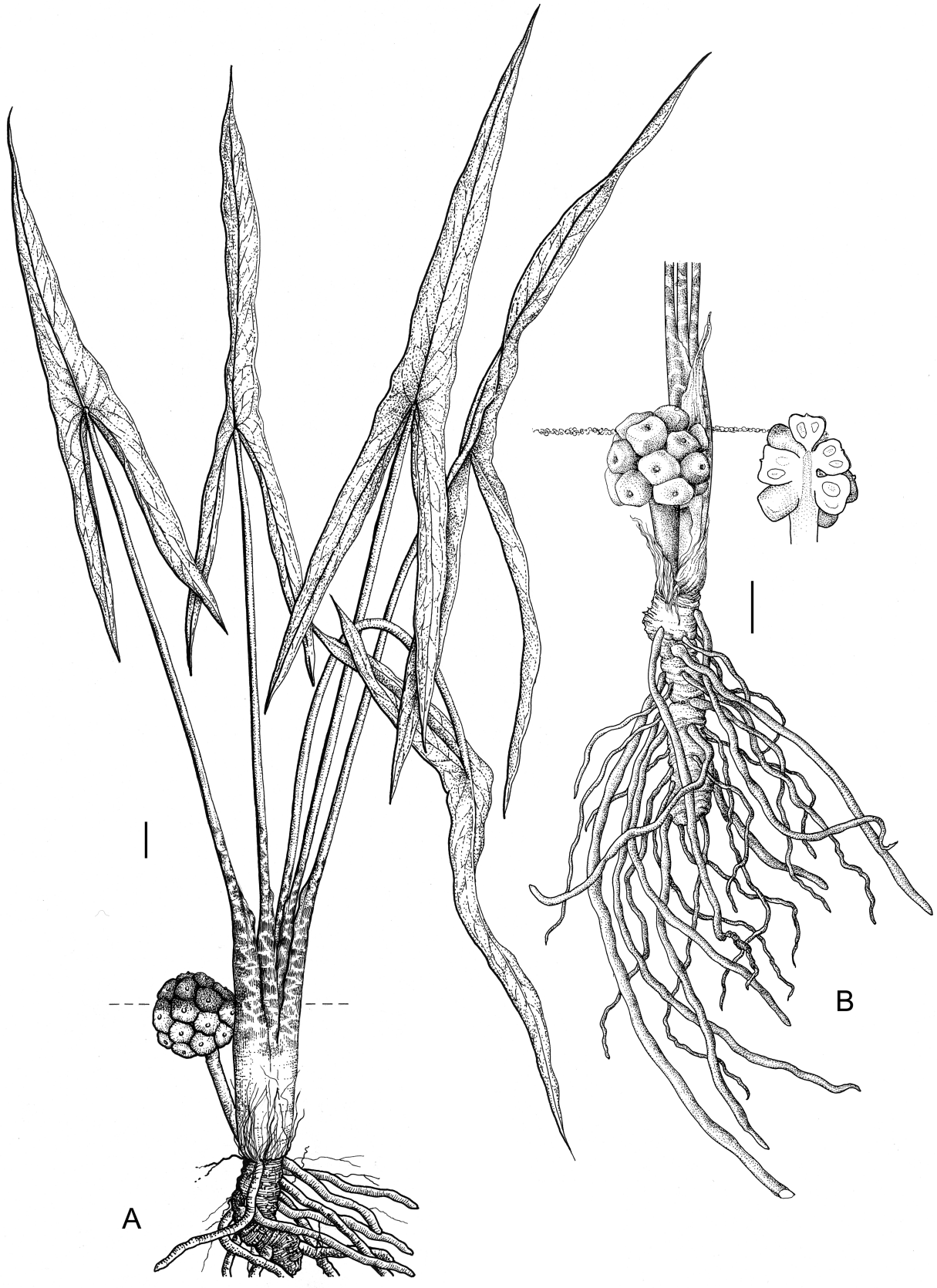

FIGURE 2. *Stylochaeton glaucophyllum*. **A.** Plant with mature infructescence borne partly below-ground; dashed line indicates soil level. **B.** Vertical rhizome with sturdy, though non-tuberous roots, and mature infructescence, the latter intact (left) and as seen in longitudinal section (right); horizontal band of stippling indicates soil level. Scale bar = 10 mm. Artists: Anne Stadler (A) and Gillian Condy (B).

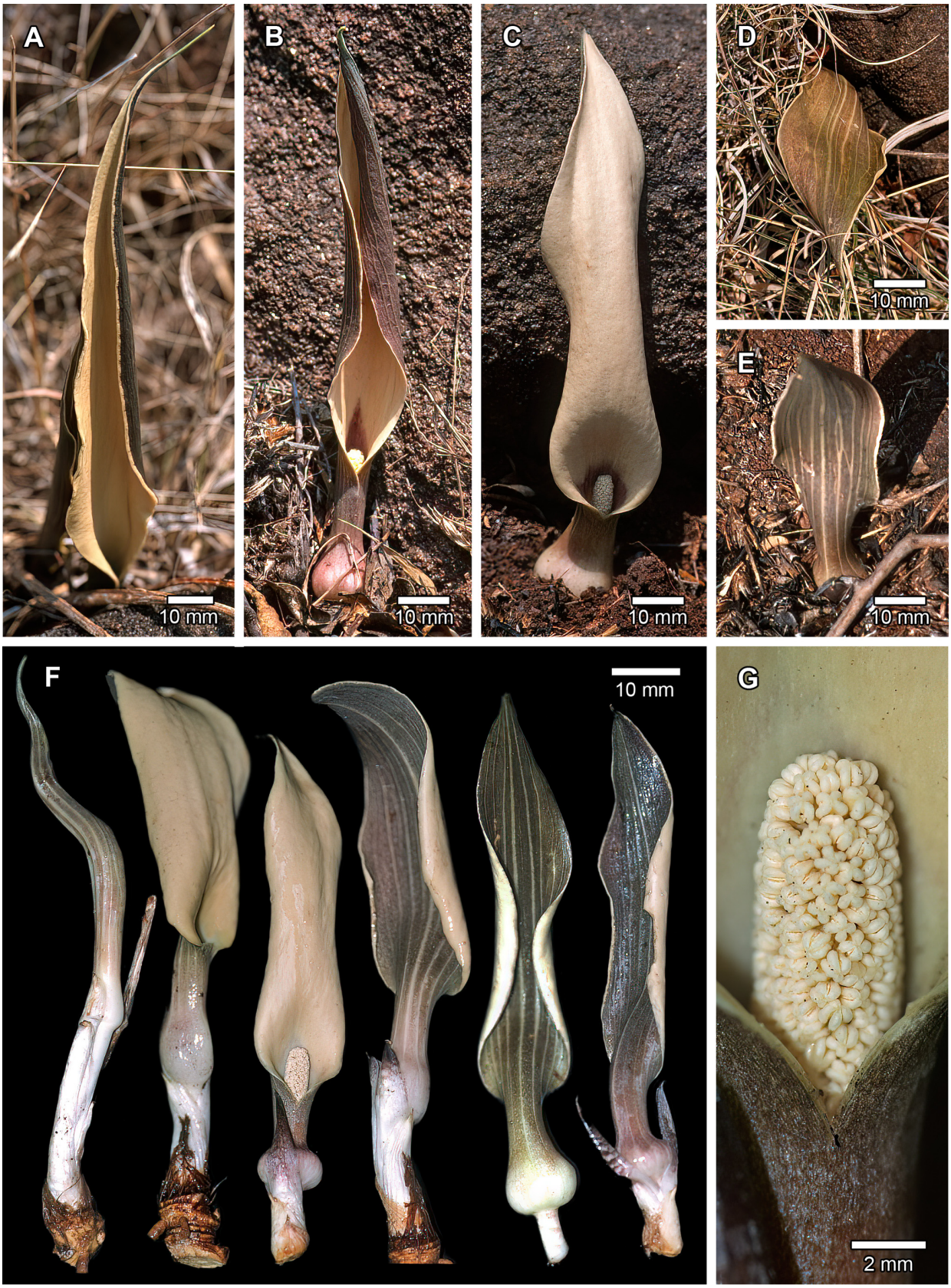

FIGURE 3. *Stylochaeton glaucophyllum*, morphology of inflorescence. **A.** Inflorescence at start of anthesis. **B.** Inflorescence partly open; note dark central blotch. **C.** Fully opened inflorescence, with dark central blotch and spadix protruding somewhat from the spathe-tube. **D.** Inflorescence with spathe in dorsal view to show cryptic coloration among dry grass. **E.** Inflorescence with spathe in dorsal view to show coloration; flowering in a recently burned area. **F.** Inflorescences removed from plants and with soil cleaned from basal parts, seen from different angles; inflorescence on far-left still in bud. **G.** Upper part of spadix with staminate flowers and protruding from the spathe-tube. Photographs: S.J. Siebert.

FIGURE 4. *Stylochaeton glaucophyllum*, morphology of infructescence. **A.** Plant with mature infructescence, the latter borne partly below-ground; some soil has been removed from around the infructescence to show the upper purplish surface visible above-ground and the lower whitish part that were below-ground. **B.** Infructescence removed from the soil; the bulk of it was below-ground, with only the area tinged greenish purple at the top exposed above-ground. **C.** Infructescence with purplish colouration indicating that most of the berries were borne above-ground. **D.** Infructescence that were mainly borne below-ground as indicated by the broad whitish lower part. Photographs: A.E. van Wyk (A, C & D) and S.J. Siebert (B).

Phenology:—Flowers appear from September to November (spring) and ripened fruit can be observed from December to January (summer).

Etymology:—The specific epithet is a compound word derived from the Greek *glaucos* = greenish blue or seagreen, dull green, passing into greyish blue + *phyllon* = leaf (Stearn 1992). It refers to the greenish blue color of the leaves. The generic name is treated as neuter, as this is how it was originally published (Nicolson & Mayo 1984). The local vernacular name in English for *S. natalense* (Fig. 1) is "bushveld arum" and in Afrikaans *bosveldvarkoor*. As English and Afrikaans names for the new species we propose "blue bushveld arum" and *bloubosveldvarkoor,* respectively.

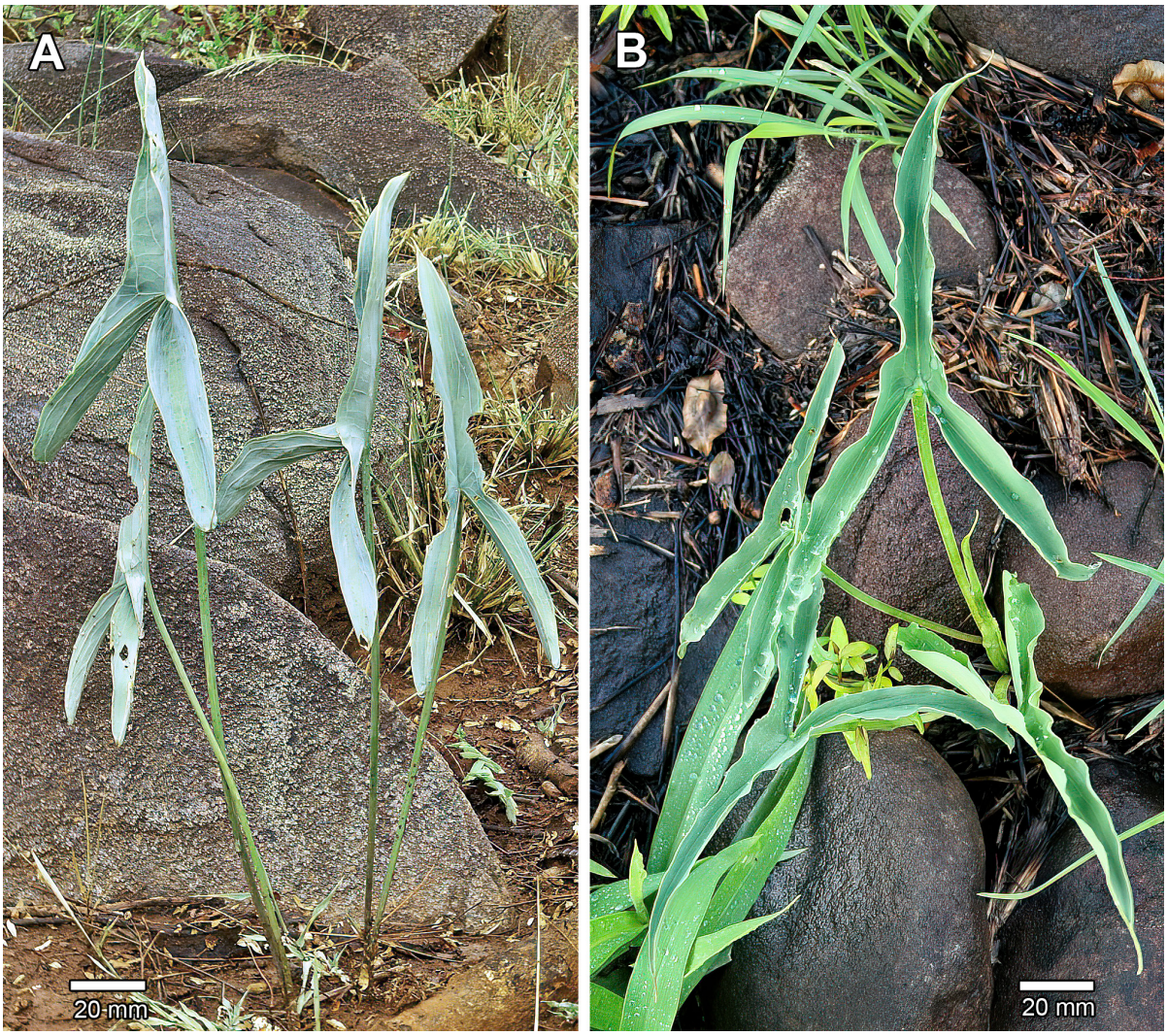

FIGURE 5. *Stylochaeton glaucophyllum* and *S. sekhukhuniense*, habit and habitat. **A.** *S. glaucopyllum*, two plants, each with two leaves, growing among norite rocks. **B.** *S. sekhukhuniense*, plant growing among norite rocks and with black burned plant material indicating that the plant has sprouted after a recent wild fire. Photographs: A. Klopper (A) and S.J. Siebert (B).

Distribution:—*Stylochaeton glaucophyllum* is endemic to the Sekhukhuneland Centre of Plant Endemism (Fig. 6), Limpopo Province, South Africa. It grows in bushveld (savannah) with well-drained stony, clay soil along gentle to moderate slopes.

Habitat:—The core area of the Sekhukhuneland Centre of Endemism is more or less congruent with surface outcrops of the Rustenburg Layered Suite, one of the stratigraphic units of the eastern Bushveld Complex (Scoon & Viljoen 2019). This igneous complex is characterised by mafic and ultramafic rocks, the latter that give rise to soils that are often rich in heavy metals (Adhikari *et al*. 2022). As is the case with many plant species largely confined to the Sekhukhuneland Centre, *S. glaucophyllum* grows mainly on pyroxenite and norite outcrops and hillsides (Siebert *et al*. 2001), in closed Sekhukhune Mountain Bushveld (mapping unit: SVcb 28) (Mucina & Rutherford 2006) characterized by the trees *Combretum apiculatum* Sonder (1850: 45)*, Kirkia wilmsii* Engler (1897: 25) and *Senegalia nigrescens* (Oliver 1871: 340) Hurter (2008: 1021), and commonly associated with *Corbichonia decumbens* (Forsskål 1775: 103) Exell (1935: 80), *Hibiscus coddii* subsp. *barnardii* (Exell 1959: 177) Leistner & Winter (2005: 95), *Cyphocarpa angustifolia* Lopriore (1899: 45) and *Melhania prostrata* Burchell (1824: 263) in the forb layer. Populations are usually small and localized, and may be found in close proximity to, or intermixed with, populations of *Stylochaeton natalense* (Fig. 1).

Stylochaeton glaucophyllum grows in slightly acidic (pH 5.5) ultramafic soil (Ca/Mg ratio 0.68) rich in metals such as Al and Fe, and to a lesser extent Cr, Mn, Ni and Ti (Table 1). Although nutrient levels are above 4000 mg/kg for essential elements, such as K, the EC is low (40 mS/m) suggesting that nutrients are not readily available in the soil (Table 1) and therefore contributing to the "serpentine soil effect" typical for ultramafic areas (O'Dell *et al.* 2006).

TABLE 1. Soil nutrient status and trace metal element concentrations for soil and leaves of both new species of *Stylochaeton*. A Bio-accumulation Factor (BIF) of >1 indicates that a species accumulates higher levels of a trace element in its tissue than the soil concentrations. *S. gla*: *Stylochaeton glaucophyllum*; *S. sek*: *S. sekhukhuniense*.

	Soil		**Leaves**		**BIF**	
	S. gla	***S. sek***	***S. gla***	***S. sek***	***S. gla***	***S. sek***
pH (KCl)	5.5	5.3	-	-	-	-
EC (mS/m)	40	30	-	-	-	-
CEC	21.55	20.44	-	-	-	-
S-value	15.92	14.44	-	-	-	-
Base saturation (%)	69.68	64.25	-	-	-	-
Ca:Mg	0.68	0.51	-	-	-	-
Al (mg/kg)	21,312	16,954	11.675	17.934	<0.001	<0.001
B	2.213	1.567	4.352	6.458	1.966	4.122
Ca	3,051	1,669	1,692	1,287	0.555	0.771
Cr	448	720	0.338	0.533	<0.001	<0.001
Fe	31,270	38,770	23.087	27.193	<0.001	<0.001
K	4,080	3,722	2,442	2,781	0.598	0.747
Mg	4,323	3,571	368.23	435.37	<0.01	<0.5
Mn	635	722	13.609	9.811	<0.1	<0.01
Na	416	183	22.958	31.112	<0.01	<0.5
Ni	175	238	0.392	0.322	<0.001	<0.001
P	451	554	153.85	167.87	<0.5	<0.5
S	496	1367	228.64	219.68	<0.5	<0.5
Ti	771	721	0.638	0.885	<0.001	<0.01

Conservation status:—*Stylochaeton glaucophyllum* is not known from any statutory conservation areas. It is subjected to especially human population pressure, subsistence and commercial farming and extensive mining for platinum and chromium. It is assessed as Endangered according to IUCN Red List categories and criteria (IUCN 2012) due to the < 5000 km^2 (i.e., 869 km^2) extent of occurrence and < 10 km^2 (i.e., 4.6 km^2) area of occupancy, and the existence of only nine known populations (Siebert *et al*. 2002).

Notes:—The inflorescences of *S. glaucophyllum* are cryptically coloured and easily overlooked as they tend to blend in with the colours of the associated dry grass, rocks, and soil during the flowering period in spring (Fig. 3A–E). When ripe the berries in an infructescence (Fig. 4) become soft and emit a strong but pleasant scent reminiscent of that of a ripe mango fruit. The colour of infructescences does not change significantly upon ripening (whitish underground, greenish or purplish above-ground), although the pulp of the berries becomes slightly yellowish. The strong scent suggests that the fruit is most probably consumed by an animal that also facilitates seed dispersal.

The leaf shape of *Stylochaeton glaucophyllum* is very similar to that of *S. borumense* Brown (1901:191), *S. hypogeum* Leprieur (1834: 185) and *S. oligocarpum* Riedl (1990: 297) (although these three species do not occur in South Africa). These species differ in that the basal lobes of the leaf blade are shorter (25–120 mm) than the apical lobe (63–200 mm), at a ratio of ca. 1:2, whereas in *S. glaucophyllum* the basal lobes are almost the same length (54–160 mm) as the apical lobe (58–172 mm). The basal lobes of *S. oligocarpum* are characteristically spread horizontally. The spathe of *S. borumense* is glaucous green to yellow green and the staminate and pistillate flowers are separated by an area (2–12 mm) with few to 10 sterile flowers. The spathe of *S. glaucophyllum* is various shades of brown with usually longitudinally creamish stripes and the staminate flowers are contiguous with the pistillate flowers. There are only two pistillate flowers in the inflorescence of *S. oligocarpum* whereas *S. glaucophyllum* has 10 or more pistillate flowers. The style in *S. hypogeum* is bottle-shaped, but in *S. glaucophyllum* the style is not thickened below the middle. The leave blades of *S. natalense* (Fig. 1) are wide (ca. 150 mm) and variable in shape (ovate to triangular to sagittate-hastate or hastate-cordate) while those of *S. glaucophyllum* are narrow (ca. 27 mm) and sagittate. The spathe of *S. natalense* (Fig. 1B) is yellowish or purplish, whereas in *S. glaucophyllum* it is cream-coloured or brownish with paler longitudinal stripes (Table 2). For notes on the distinction between the two new species, see "Differences between *Stylochaeton glaucophyllum* and *S. sekhukhuniense*" under *S. sekhukhuniense*.

This species was referred to as *Stylochaeton* sp. S 1332 in Siebert *et al*. (2002: 138).

TABLE 2. Selected features to distinguish among *Stylochaeton glaucophyllum*, *S. sekhukhuniense,* and other morphologically similar southern African species of *Stylochaeton*. Information from Brown (1901), Haigh & Bogner (2012), Mayo (1985); Thulin (1995), and the present study.

	S. glaucophyllum	*S. sekhukhuniense*	*S. borumense*	*S. hypogeum*	*S. oligocarpum*	*S. natalense*
Leaves shape	Narrowly saggitate	Saggitate	Saggitate, saggitate-hastate	Hastate, hastate-saggitate	Hastate-saggitate	Ovate, triangular, saggitate, saggitate-hastate, cordate-saggitate
Leaf size:	Basal lobe: 54–160 × 4–20 mm Apical lobe: 58–172 × 5–27 mm	Basal lobe: 55–80 × 8–26 mm Apical lobe: 25–50 × 3–30 mm	Basal lobes: 25–50 × 3–30 mm Apical lobe: 63–152 × 6–60 mm	Basal lobe: 25 mm long Apical lobe: 76–152 mm	Basal lobe: 70–120 × 8–17 mm Apical lobe: 140–200 × 15–20 mm	50–310 × 18–260 mm
Spathe colour (outside)	Brownish, yellowish brown or purplish brown	Brownish olive green	Glaucous green to pale yellow green, often purplish brown to apex	Brown	Unknown	Greenish to yellowish or purplish.
Spadix	Male and female flowers contiguous	Male and female flowers contiguous	Male and female flowers separated by 2–12 mm of few to 10 sterile flowers	Male and female flowers separated by 20 mm of sterile flowers	Unknown	Male and female flowers contiguous
Number of female flowers	10 or more	10 or more	5 or 6	6 or more	2	20–40
Style	Unthickened	Unthickened	Unthickened	Thickened below the middle	Unknown	Unthickened

Additional specimens examined (paratypes):—SOUTH AFRICA. Limpopo: Mecklenburg: Thokane, near Vodacom tower on summit of mountain (2430AC), 12 December 2000, *Van Wyk 13596* (PRU!); Burgersfort, banks of Steelpoort River (2430CB), 20 November 2009, *Siebert 4452* (PUC!); Steelpoort, Driekop (2430AC), 27 January 2012, *Siebert & Rajakaruna 4462* (PRU!); Manyaka, hill behind primary school, Ga-Mashishi (2430AC), 29 September 2000, *Siebert 1845* (PRU!); Burgersfort, Getlane Lodge, on road between Burgersfort and Lydenburg (2430CD), 5 December 1999, *Van Wyk & Siebert 1374* (PRU!).

Stylochaeton sekhukhuniense Struwig, S.J.Siebert & A.E.van Wyk, *sp. nov.* (Figs 4B & 7)

In habit approaching forms of *S. borumense* with sagittate leaf blades, but differs in the spadix having male and female flowers contiguous and the filaments not thickened (*vs.* male and female flowers separated by a zone of few to 10 sterile flowers and filaments thickened towards apex). Morphologically most similar to *S. glaucophyllum*, differing in having scattered trichomes on petiole immediate distal to petiolar sheath (*vs.* glabrous); petiolar sheath distinctly ligulate (*vs.* not ligulate); leaf blade short, 44–180 mm (*vs.* longer, 112–332 mm) with basal and apical lobes elliptic (*vs.* linear), green (*vs.* greenish blue); spadix entirely enclosed by spathe-tube (*vs.* protruding somewhat from spathe-tube).

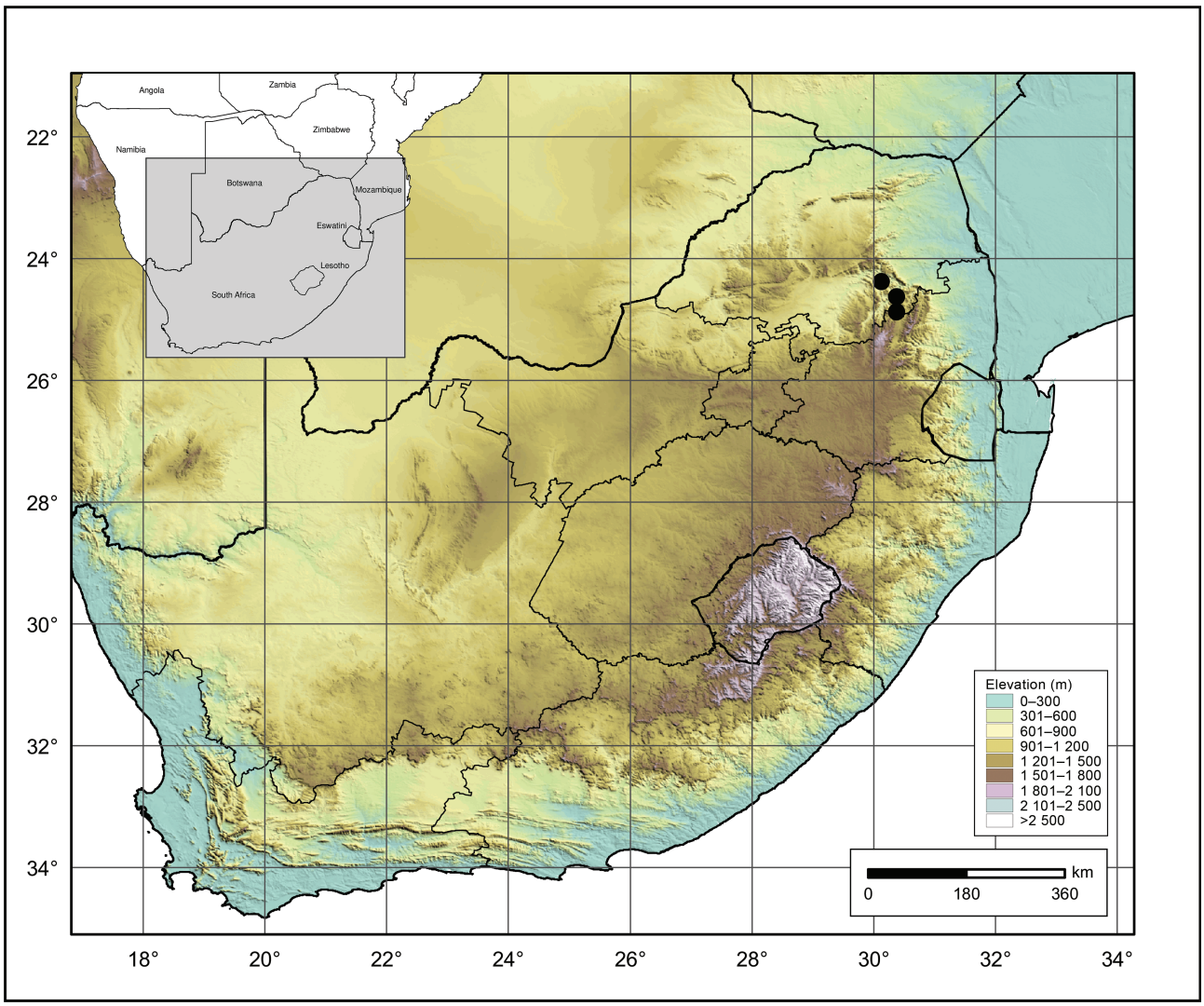

FIGURE 6. Topographical map showing the known distribution (black dots) of *Stylochaeton glaucophyllum*. The insert shows a map of southern Africa with names of countries; the grey rectangle indicates the area depicted by the topographical map.

Type:—SOUTH AFRICA. Mpumalanga: Steelpoort, farm adjacent to Kennedy's Vale where Dwars River breaks through hill, 2430CC, 10 March 1998, *Siebert 390* (holotype PRU!).

Geophyte, with vertical rhizome, ca. 48 × 9 mm; roots stout, not tuberous. Cataphylls fibrous. *Leaves* 2–5; petioles 100–300 mm long, lower ⅓ usually covered with transverse purplish and greenish white speckles or bands, upper

⅔ green; petiolar sheath up to 75 mm long, with transverse bands, apex distinctly ligulate, extend into two slender, curling elongations (ligulae) ca. 30 × 3 mm, apex obtuse, margin undulate; ⅓ of petiole immediately distally to sheath often with scattered trichomes, distal ⅔ glabrous; blade sagittate, apical lobe 24–100 × 5–30 mm, elliptic, mucro up to 12 mm long, basal lobes 20–80 × 8–26 mm, elliptic, tips rounded; green, glabrous, margin entire or slightly repand, midvein and basal veins prominent. *Inflorescence* with peduncle ca. 34 × 7 mm; spathe ca. 111 mm long, glabrous, thickened, inside (ventrally) cream-coloured to pale buff, outside (dorsally) brownish olive-green, distinctly or vaguely longitudinally striped with creamish lines (veins), veins somewhat ribbed on outer surface; basal tube erect, ca. 29 mm long, upper part cylindrical, ca. 14 × 10 mm, lower part inflated, globose, ca. subterranean, ca. 15 × 15 mm; upper limb ca. 82 × 22 mm, oblong, acuminate, apex with cusp ca. 7 mm long. *Spadix* ca. 24 mm long, not projecting from spathe-tube; monoecious; staminate part cylindric, ca. 15 × 6 mm, many-flowered, contiguous with pistillate part, pistillate part hemispherical, ca. 9 × 11 mm, flowers in two rows. *Staminate flowers* with perigone cupular, rhomboid, thickened, connate; stamens 3, filaments filiform, ca. 1 mm long; anthers globose, basifixed, extrorse. *Pistillate flowers* with perigone cupular, contracted at the mouth, subregular, 4–6-sided, thickened, connate; stamens 0; ovary subglobose, 1-locular; style stout, ca. 3 mm long, exserted, stigma discoid, 1 mm broad. Fruit unknown, but infructescence suspected to be borne partly below-ground.

Phenology:—Inflorescences have been recorded in October and November (spring); infructescences not seen.

Distribution and habitat:—*Stylochaeton sekhukhuniense* is endemic to the Sekhukhuneland Center of Endemism, Limpopo province, South Africa (Fig. 8). It grows in bushveld (savannah) on well-drained stony, clay soil along gentle to moderate slopes. It is found in open Sekhukhune Mountain Bushveld (mapping unit: SVcb 28) and Sekhukhune Plains Bushveld (SVcb 27) (Mucina & Rutherford 2006). The dominant woody species are *Dichrostachys cinerea* (Linnaeus 1753: 520) Wight & Walker-Arnott (1834: 271), *Searsia engleri* (Britten 1900: 316) Moffett (2007: 168) and *Terminalia prunioides* Lawson (1871: 415). Co-occurring forbs include *Justicia flava* Vahl (1791: 15), *Sansevieria hyacinthoides* (Linnaeus 1753: 321) Druce (1914: 423) and *Waltheria indica* Linnaeus (1753: 673).

Stylochaeton sekhukhuniense prefers the same soil conditions as *S. glaucophyllum*. However, its associated soil seems to be richer in S, but poorer in Ca (Table 1). The serpentine soil effect is still maintained. Both species exhibited bio-accumulation of boron, whereas *S. glaucophyllum* accumulated 2× the total amount in the soil, *S. sekhukhuniense* accumulated at 4×. Boron is an essential element required for plant growth, and plants accumulate this element when levels in the soil are low (Pereira *et al*. 2021).

Conservation status:—*Stylochaeton sekhukhuniense* is assessed as Endangered according to IUCN Red List criteria (2012) due to the extent of occurrence < 5000 km^2 (i.e., 218 km^2), but with less than 10 km^2 (i.e., 3.4 km^2) area of occupancy, and the existence of seven known populations (Siebert *et al*. 2002). *Stylochaeton sekhukhuniense* is, however, increasingly subjected to habitat degradation as a result of extensive mining activities and urban expansion in the Sekhukhuneland region.

Etymology:—The specific epithet "*sekhukhuniense*" refers to "Sekhukhuneland", the geographical region to which the species is endemic. The region derives its name from that of the 19th century Bapedi king, Sekhukhune I [ca. 1814–1882] (Raper *et al.* 2014). As English and Afrikaans names for the new species we propose the name "Sekhukhune bushveld arum" and *sekhukhunebosveldvarkoor* respectively.

Notes:—*Stylochaeton sekhukhuniense* is less well known than *S. glaucophyllum* and there is a need for more information on the former, notably its inflorescence. The species' infructescence has also not yet been recorded, although based on similarities in inflorescence morphology, it is suspected to be rather similar to that of *S. glaucophyllum* and also borne below- or partly below-ground. The taxon is nevertheless immediately recognizable by the distinctly ligulate petiolar sheaths.

The apex of the cataphylls or petiolar sheaths of several species of *Stylochaeton*, e.g. *S. crassispathum* Bogner (1984: 77), *S. milneanum* Mayo (1985: 47), *S. oligocarpum* and *S. puberulum* Brown (1901: 188) are auriculated. The petiolar sheath of *S. sekhukhuniense*, however, extends into two slender elongations (ligulae) ca. 30 mm long. The leaf shape of *S. sekhukhuniense* is, as with *S. glaucophyllum,* very similar to the leaves of *S. borumense*, *S. hypogeum* and *S. oligocarpum*, with the most easily observed difference in the length of the basal and apical lobes. The basal lobes in these species are shorter (25–120 mm) than the apical lobe (63–200 mm), ca. 1:2, whereas in *S. sekhukhuniense* the basal lobes are almost the same length (20–80 mm) as the apical lobe (24–100 mm). The leaf blades of *S. natalense* (Fig. 1) are larger (50–310 × 18–260 mm) and variable in shape (ovate to triangular to sagittate-hastate or hastate-cordate) while the blades of *S. sekhukhuniense* are smaller (44–180 × 5–30 mm) and sagittate (Table 2).

This species was referred to as *Stylochaeton* sp. S 390 in Siebert *et al*. (2001) and *Stylochaeton* sp. S 672 in Siebert *et al*. (2002: 138).

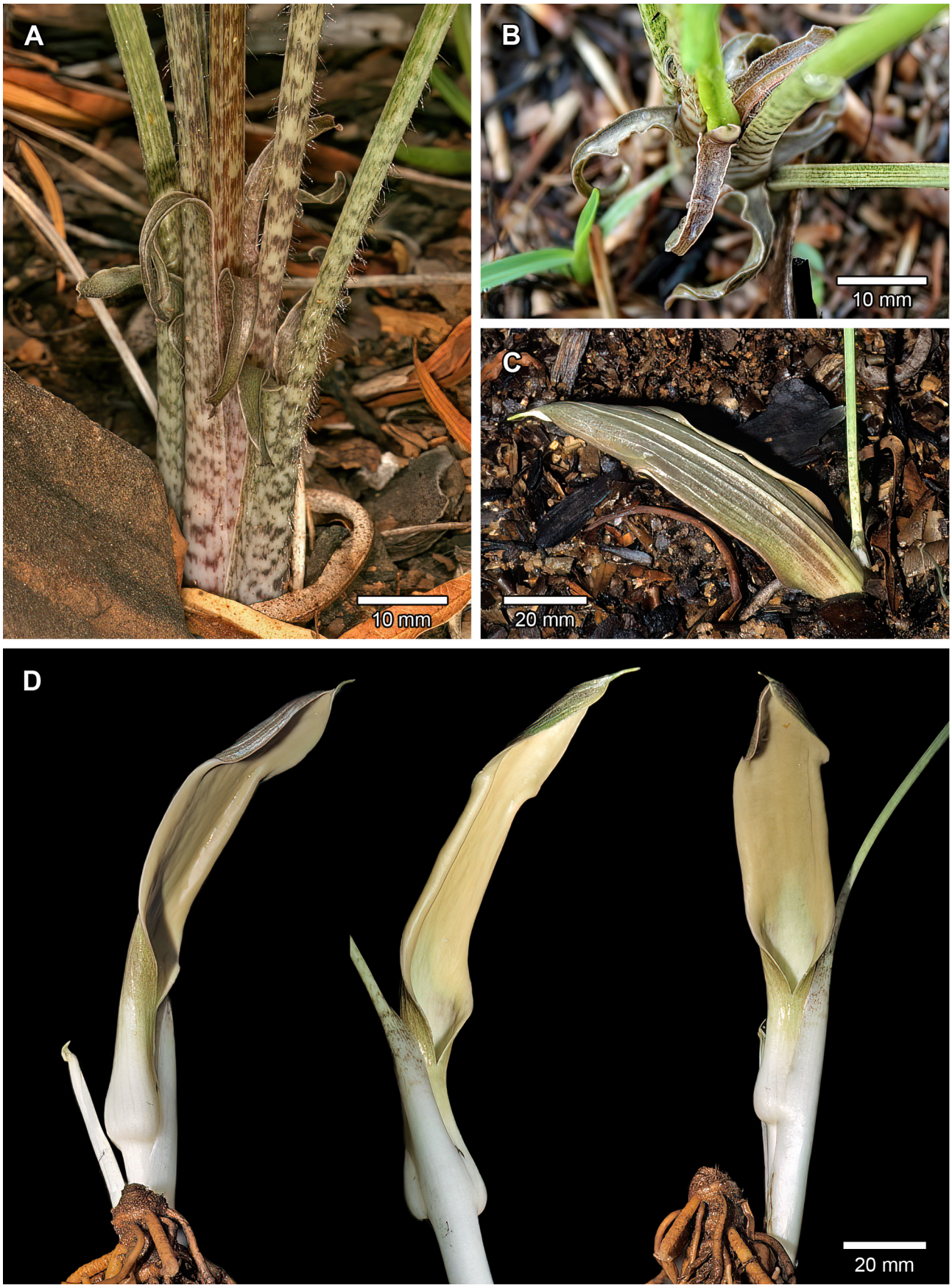

FIGURE 7. *Stylochaeton sekhukhuniense*, morphology of leaves and inflorescence. **A.** Basal part of leaves showing the distinctly ligulate petiolar sheaths; note hairs on the part of the petiole above the sheath. **B.** Petiolar sheaths with curly ligulae, viewed from above. **C.** Inflorescence with strongly forward curving spathe. **D.** Inflorescences removed from plant and soil cleaned from basal parts; viewed from different angles. Photographs: A.E. van Wyk (A, C & D) and S.J. Siebert (B).

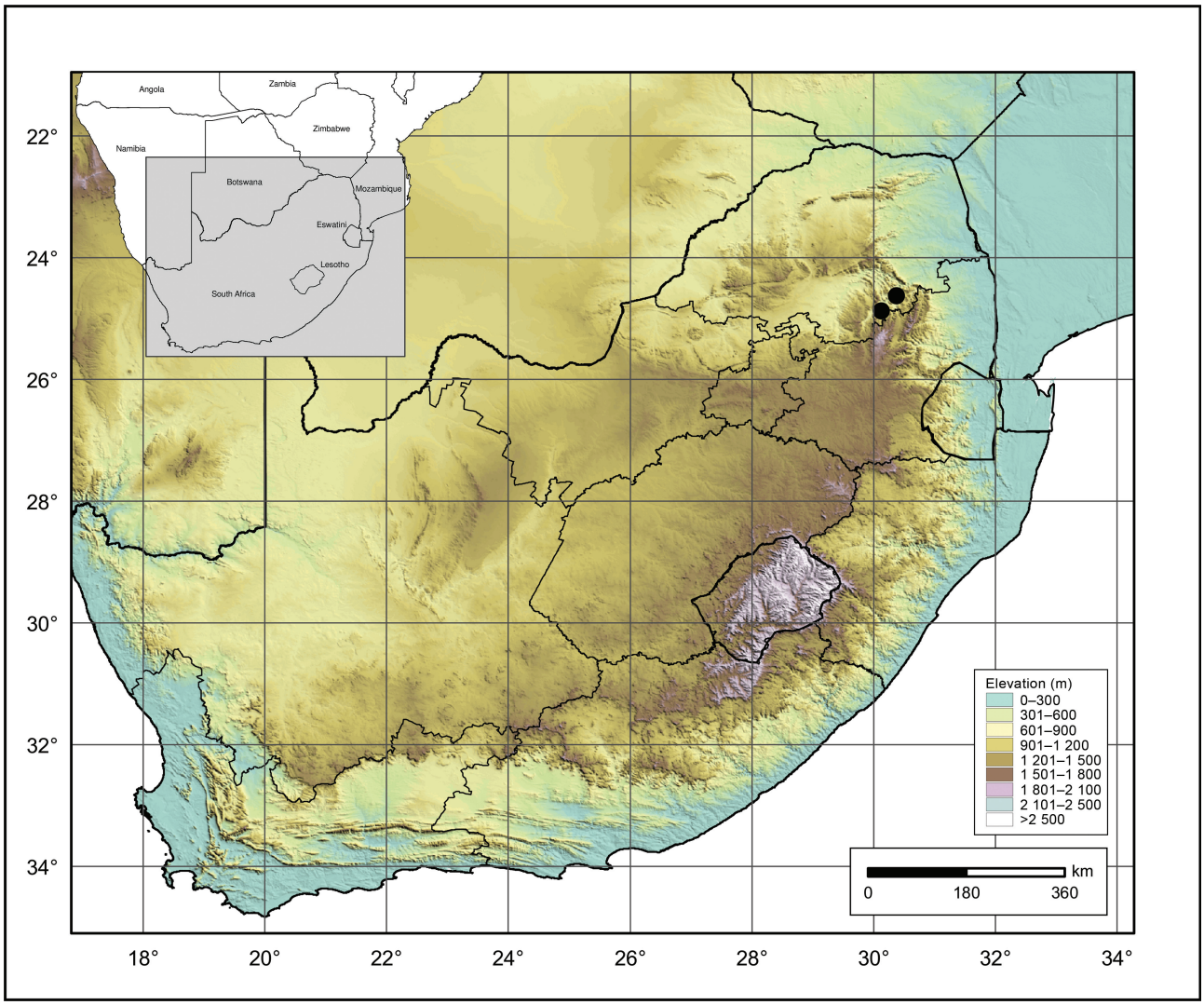

FIGURE 8. Topographical map showing the known distribution (black dots) of *Stylochaeton sekhukhuniense.* The insert shows a map of southern Africa with names of countries; the grey rectangle indicates the area depicted by the topographical map.

Differences between *Stylochaeton glaucophyllum* and *S. sekhukhuniense*:—Until additional material of *S. sekhukhuniense* is sourced, the two new species are mainly differentiated based on their vegetative morphology. The apical and basal leaf blade lobes of *S. glaucophyllum* are linear in shape, whereas for *S. sekhukhuniense* these are elliptic. The leaf blade of *S. glaucophyllum* is longer (112–332 mm) than that of *S. sekhukhuniense* (44–180 mm). The leaf blades of *S. glaucophyllum* are greenish blue and leathery, whereas those of *S. sekhukhuniense* are green and soft. The petiolar sheath of *S. sekhukhuniense* extends into two slender, curling elongations (ligulae) which are absent in *S. glaucophyllum.* The reproductive morphology of the two species, as known at present, is very similar. The inflorescences may differ slightly in spathe colour, but at this stage very few of them were seen in *S. sekhukhuniense*, hence we are hesitant to claim any colour differences of diagnostic significance. What does seem to be a potentially useful taxonomic distinction, if confirmed to be species-specific by more material, is that in *S. glaucophyllum* the spadix protrudes a short distance from the spathe tube while in *S. sekhukhuniense* it is entirely enclosed within.

Additional specimens examined (paratypes):—SOUTH AFRICA. Limpopo: Steelpoort, Richmond, opposite Richmond turn-off (2430CC), 10 December 1998, *Siebert 672* (PRU!); Burgersfort, banks of Steelpoort River (2430CB), 11 November 2009, *Siebert 4451* (PUC!).

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