

## A new species of *Polygala* (Polygalaceae) from ultramafic soils in Sekhukhuneland, South Africa, with notes on its ecology

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### Abstract

*Polygala sekhukhuniensis* Retief, Siebert & A.E. Van Wyk (*Polygala*; section *Polygala*; subsection *Heterolophus*), a new species with a restricted range in Sekhukhuneland, South Africa, is described, illustrated and compared with other members of the genus. It is a dwarf shrub that can be distinguished by its much-branched habit, sparsely flowered inflorescences, pink alae with darker pink veins, brown to black seed testa, and oblate pollen grains with pronounced opercula. Geographically, *P. sekhukhuniensis* is confined to heavily eroded localized sites, a natural geomorphological feature of some of the highly water-dispersible soils derived from ultramafic rocks in the valleys of the Steelpoort River and its tributaries in the Sekhukhuneland Centre of Plant Endemism. *P. sekhukhuniensis* is a calcitrophic excluder of heavy metals that accumulates Ca in its leaves. It is ecologically compared with co-occurring species of *Polygala* on ultramafic-derived soil.

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### 1. Introduction

Since the pioneering work of Wild (1965) on plants associated with soils rich in heavy metals and derived from ultramafic rocks in southern Africa, and subsequent ground-breaking research on plant-soil associations on southern African serpentinites by Morrey et al. (1989), Williamson et al. (1997) and Balkwill and Campbell-Young (2001), many plant species new to science have been described from such substrates. In recent years the Sekhukhuneland Centre of Plant Endemism (SCPE) in South Africa has been highlighted as an area harbouring potential new plant species (Van Wyk and Smith, 2001). Siebert et al. (2001) showed that the high levels of plant endemism of this region are significantly correlated with the heavy metal soils derived from ultramafic rocks. In the last three years, six new endemic plant species (including a new monotypic genus, *Prototulbaghia*) were described from the SCPE (Venter et al., 2007; Vosa, 2007; Burrows and Burrows,

2008; Hankey et al., 2008; Retief et al., 2008; Manning and Goldblatt, 2009).

Massoura et al. (2004) have shown that plant species adapted to heavy metal soils often accumulate or exclude metals that are present in the soil at high concentrations. This physiological adaptation is usually also expressed in the morphology through ecological speciation (Balkwill and Campbell-Young, 2001; Retief et al., 2008). Subsequent studies on heavy metal accumulation by plants in the SCPE by Mandiwana et al. (2007) have revealed several metal accumulators and excluders. Such species are known to be genetically different from their widespread congeners (Yang et al., 2005). This has warranted taxonomic investigation into one such excluder that is tolerant of soils rich in heavy metals, a member of *Polygala* that was initially considered an ecotype of *P. leptophylla* Burch. var. *leptophylla*. However, subsequent field work and comparative morphological studies have shown the putative ecotype to be a distinct new species related to members of section *Polygala*, subsection *Heterolophus* (Paiva, 1998), specifically *P. hottentotta* Presl., *P. leptophylla* var. *leptophylla* and *P. seminuda* Harv. It is confined to areas of highly water-dispersible soils derived from

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ultramafic rocks. The new species is here described as *Polygala sekhukhuniensis* Retief, Siebert & A.E. Van Wyk. This is the second excluder of heavy metals, after *Euclea sekhukhuniensis* (Retief et al., 2008), that is strictly confined to localized areas of naturally eroded, ultramafic soils in Sekhukhuneland.

The aim of this paper is to describe and name the new taxon, and highlight the morphological, palynological and ecological differences between the taxon and its most closely related congeners.

## 2. Materials and methods

### 2.1. Morphological assessment

Live material of the new species was extensively studied in the field. Its morphology was compared to existing descriptions and treatments of the genus (Exell, 1960; Paiva, 1998). Specimens of *Polygala* housed in the National Herbarium (PRE), Pretoria and H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria, were examined to gather quantitative and qualitative data on morphology, phenology and distribution of the new species, as well as related taxa. Micrographs of seed were taken with a Nikon Digital Camera DXM 1200 F fitted on a Nikon SMZ 1500 stereomicroscope. Seed terminology follows Paiva (1998).

### 2.2. Palynological assessment

Mature, unopened flower buds from herbarium specimens were dissected to obtain anthers with pollen. Unacetolyzed pollen grains were mounted onto aluminium stubs, sputter-coated with gold/palladium (Au/Pd) and examined with a FEI Quanta 200 ESEM Scanning Electron Microscope (SEM). Ten pollen grains per species were measured for polar length (*P*) and equatorial width (*E*). Palynological terminology follows Punt et al. (1994).

### 2.3. Plant-soil assessment

Plant material of the new species and *P. hottentotta*, as well as soil samples were collected during early summer, environmental factors were noted and associated plant communities identified (Siebert et al., 2002). Samples were taken at ten sites, five each dominated by either species. Soil analyses was done with X-Ray Fluorescence (XRF) Spectrometry and plant analyses with Atomic Absorption Spectrophotometry (AAS) as well as Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Terminology describing exclusion mechanisms follows Massoura et al. (2004).

## 3. Taxonomy

The subcosmopolitan family, Polygalaceae, comprises about 19 genera and 925 species (Mabberley, 1997). The flowers are superficially similar to those of members of the subfamily Papilionoideae (Fabaceae). However, the wings (alae) of *Polygala* flowers belong to the calyx and not to the corolla. The standard is completely different and *Polygala* has a crest at the tip of the keel. Currently various studies (Prenner, 2004; Banks

et al., 2008) confirm the placing of the erstwhile order Polygalales in an expanded order Fabales (APG II, 2003). In the Flora of southern Africa region, the genus *Polygala* is represented by ±88 species (Bredenkamp, 2000), of which ten are currently known from the SCPE.

*Polygala sekhukhuniensis* Retief, Siebert & A.E. Van Wyk, sp. nov.; *fruticulus pumilus caulibus patentibus caudice lignoso; caules foliaque sparse apprese hirsuti; folia spiraliter disposita, laminae linearo-oblonge vel obovata, apice mucronata; calyx sepalis duobus aliformibus, alis roseis; corolla carina cristata, crista atrorosea vel purpurea.*

Type. — 2430 (Pilgrim's Rest): Mpumalanga, Thornecliffe Chrome Mine, turn off from Lydenburg-Sekhukhune road, [1 December 1997], Van Wyk 13031 (PRU, holo.; PRE, iso.).

Rigid perennial shrublet, 0.2–0.4 m high, with a woody rootstock; stems and leaves sparsely adpressed-hairy; hairs unbranched. *Stems* usually more than four from rootstock, erect and spreading, branched, woody at base; young branches green, herbaceous. *Leaves* spirally arranged, shortly petiolate; petiole up to 0.75 mm long; blade linear-oblong or obovate, 7–15 × 1.0–2.5 mm, apex obtuse, occasionally acute, mucronate, margin entire. *Inflorescences* comprising terminal racemes, peduncle up to 80 mm long, pedicels 1.75 mm long. *Flowers* irregular; bisexual, drooping. *Calyx* pentamerous, with sepals unequal, three outer ones sepaloid, two inner ones petaloid, larger wing-like, 6–8 × 3.5–5.0 mm, all free; wings pink with darker pink veins. *Corolla* of five petals, lowest one forming a carina, crested, crest dark pink to purple, two lateral ones usually vestigial or absent, two upper ones joined at base to carina and staminal tube. *Stamens* eight, basally fused for ±two-thirds their length. *Ovary* superior, two locular. *Fruit* a laterally compressed capsule, up to 6.5 mm long, membranous, edges wing-like, 0.25 mm wide, deeply notched at apex, 2-seeded. *Seed* 4.5 × 1.5 mm, ellipsoid, caruncle oblique, appendages poorly developed, single one membranous, paired ones chitinous; indumentum silky white, ±1 mm longer than seed; testa dark-brown to black. *Flowering time*: November to June. (Fig. 1).

### 3.1. Diagnostic characters and key to species

*Polygala sekhukhuniensis* and two related species, *P. hottentotta* and *P. leptophylla*, are distinguished from *P. seminuda* and the rest of the genus by their narrowly ovate leaves, free anterior sepals, terminal racemes, wings not more than 6 mm broad, and the carina 6 mm long with crest 1–3 mm long. *P. sekhukhuniensis* and *P. leptophylla* differ from *P. hottentotta*, with the latter one having longer peduncles (124 mm versus 78–90 mm), greater number of flowers per raceme (23 versus 7–12), larger flowers (wing length 7.8 mm versus 6.8–7.0 mm), and smaller seed (4.3 × 1.5 mm versus 5.6–5.9 × 1.9 mm) (Table 1).

Morphologically *P. sekhukhuniensis* most closely resembles *P. leptophylla* var. *leptophylla*, however, the leaf size of the former is 7–15 × 1–2.5 mm, whereas the leaves of the latter one are 14–22 × 1.5–3 mm (Table 1). Flowers of *P. sekhukhuniensis* differ from *P. leptophylla* var. *leptophylla* in the crest of the former being purple and the alae pink with darker pink veins, whereas the crest is white, pink or purple in the latter, with the

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