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

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Keywords: Ebenaceae, *Euclea* Murray, ecology, new species, Sekhukhuneland, South Africa, summer rainfall region, taxonomy

ABSTRACT

Euclea **sekhukhuniensis** Retief, Siebert & A.E.van Wyk, 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 gregarious geoxylic suffrutex forming large, much-branched colonies. The species is closely related to the small tree/shrub *E. linearis* Zeyh. ex Hiern from which it can be distinguished by its larger fruits, broader leaves and exclusively suffrutex growth form. Geographical range and habitat preference also differ between the two taxa. *E. sekhukhuniensis* is endemic to the Sekhukhuneland Centre of Plant Endemism, where it is confined to the calcareous, heavy-metal soils of the Steelpoort River Valley.

INTRODUCTION

Areas underlain by ultramafic rocks in Mpumalanga and Limpopo, and adjacent parts of Zimbabwe, contain a rich but still poorly studied flora. Examples of taxa newly described from these substrates include *Searsia pygmaea* (Anacardiaceae) from serpentinite near Barberton (Moffett 1999), *Rhoicissus sekhukhuniensis* (Vitaceae) from norite/pyroxenite near Steelpoort (Retief *et al.* 2001) and *Peristrophe serpenticola* from the Great Dyke (Balkwill & Campbell-Young 2001). Recent vegetation surveys of the ultramafic rocks of the Sekhukhuneland Centre of Plant Endemism (SCPE), a microregional centre of plant endemism and diversity (Van Wyk & Smith 2001), have revealed many undescribed plant taxa endemic to this phytogeographical region (Siebert *et al.* 2001). Future floristic surveys in this under-collected region are likely to reveal many new distribution records and possibly further new taxa. Other species known to be endemic to the SCPE include *Raphionacme villicorona* (Apocynaceae), *Asparagus sekukuniensis* (Asparagaceae), *Acacia ormocarpoides*, *A. sekhukhuniensis*, *Elephantorrhiza praetermissa* (Fabaceae), *Euphorbia barnardii*, *E. sekukuniensis* (Euphorbiaceae), *Gladiolus sekhukhuniensis* (Iridaceae), *Plectranthus porcatus*, *P. venteri* (Lamiaceae), *Hibiscus coddii* subsp. *barnardii* (Malvaceae), *Searsia batophylla*, *S. sekhukhuniensis* (Anacardiaceae), *Zantedeschia jucunda* and *Z. pentlandii* (Araceae).

The SCPE lies to the west of the northeastern section of the Great Escarpment of South Africa and is characterized by a heterogeneous geology, topography and climate (Van Wyk & Smith 2001). The core area of the Centre straddles the border of Mpumalanga and Limpopo, around the towns of Burgersfort, Mecklenburg, Roossenekal, Schoonoord and Steelpoort. The SCPE is best demarcated in geological terms as the large, far-eastern outcrop of ultramafic rocks belonging to the Rustenburg Layered Suite of the eastern Bushveld Complex. These rocks are mainly norite, pyroxenite, anorthosite and ferrogabbro, with localized intrusions of magnetitite and chromitite (Viljoen & Schürman 1998). Topographically the SCPE is a mountainous area bordered by the high ground of the Drakensberg Escarpment in the north and east, the Highveld Escarpment to the south and the Springbok Flats to the west. It lies adjacent to and west of the Wolkberg (Van Wyk & Smith 2001) and Lydenburg (Schmidt *et al.* 2002) Centres of Plant Endemism, both part of the northeastern Drakensberg Escarpment.

Previously a *Euclea* taxon with a suffrutex habit and narrow elliptical leaves from Sekhukhuneland was tentatively considered a hybrid between *E. linearis* Zeyh. ex Hiern and *E. crispa* (Thunb.) Gürke subsp. *crispa* (De Winter 1963)—a suspicion based on the overlapping distribution ranges of these two species in Sekhukhuneland. However, subsequent detailed field work and comparative morphological studies have shown the putative hybrid to be a distinct new species, closely related to *E. linearis* and endemic to the ultramafic soils of the SCPE. The new species is here described as *Euclea sekhukhuniensis* Retief, Siebert & A.E.van Wyk. This is the second *Euclea* species, after *E. dewinteri* Retief (Retief 1986), an endemic of the Wolkberg Centre of Plant Endemism, that is strictly confined to the larger northeastern Drakensberg Escarpment.

The genus *Euclea* comprises ± 20 species, confined to Africa, Arabia, Socotra and the Comoro Islands, with its centre of diversity in southern Africa (Dyer 1975; Bredenkamp 2000). In addition to *E. sekhukhuniensis*, seven species and infraspecific taxa occur in the SCPE, namely *E. crispa* subsp. *crispa*, *E. divinorum* Hiern, *E. linearis*, *E. natalensis* A.DC. subsp. *angustifolia* F.White, *E. daphnoides* Hiern, *E. schimperi* A.DC. and *E. undulata* Thunb. (Table 1). However, the list is provisional, for the region is still poorly sampled. All these taxa are evergreen shrubs or trees, except *E. sekhukhuniensis*, which is an evergreen geoxylic suffrutex. A form of *E. crispa* (White 1977) along the northeastern Drakensberg Escarpment (but not entering the SCPE) exhibits the same growth form as *E. sekhukhuniensis*.

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MATERIALS AND METHODS

Euclea specimens housed in the National Herbarium (PRE), Pretoria, and H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria (acronyms as in Holmgren *et al.* 1990) were examined to gather data on morphology, phenology and distribution.

Ecological data are based on extensive field observations of *Euclea linearis* and *E. sekhukhuniensis* in the SCPE (Siebert *et al.* 2002a, b). Specimens were sampled from the region during all seasons, environmental factors were noted and plant communities identified. The specimens *Siebert 935*, *937* and *Van Wyk & Siebert 13060* were identified as typical *E. linearis* for comparing ecological traits with *E. sekhukhuniensis*. Plant material and soil samples were taken at ten sites, five each dominated by either *E. linearis* or *E. sekhukhuniensis*. Voucher specimens were taken from these sites; *Siebert 937* represents *E. linearis* and *Siebert 938* represents *E. sekhukhuniensis* (specimens kept at PRU). Soil analysis was done with X-Ray Fluorescence (XRF) Spectrometry, Department of Geology, University of Pretoria and plant analysis with Atomic Absorption Spectrophotometry (AAS) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) at the Department of Soil, Climate and Water in Pretoria.

TAXONOMY

Euclea sekhukhuniensis *Retief, Siebert & A.E.van Wyk*, sp. nov., *E. lineari* Zeyh. ex Hiern similis sed habitu (suffrutex, non frutex vel arbor parva), forma foliorum elliptica recta, non anguste elliptica nec lineari nec falcata, fructu globoso maiore (± 9 mm, non ± 5.5 mm diametro) differt.

TYPE.—Mpumalanga, 2430 (Pilgrim's Rest): 10 km NW of Maartenshoop, (–CC), *Codd 8796* (PRE, holo.; K, iso.). Figure 1.

Euclea linearis Zeyh. ex Hiern *sensu* De Winter: 94 (1963) quoad *Codd 8796*.

Woody suffrutex, 0.3–1.5 m high, forming large colonies of much-branched clones ± 5 m diam. Plants evergreen, dioecious. *Branches* ascending, slender and glabrous, except for a rust-brown granular exudate on young growth; bark grey on older stems. *Leaves* simple, subopposite, subsessile; blade oblanceolate-elliptic, straight, 25–75(–90) × 4–8(–10) mm, glabrous, leathery and smooth, except for a rust-brown granular exudate on younger leaves, usually yellowish green above and pale green below; base tapering into a very short petiole (1 mm), apex acute to rounded, margin entire, main vein and principal lateral veins prominent above and below. *Inflorescences* axillary, few-flowered, clusters or short spikes. *Flowers* regular. *Male flowers*: calyx 4-lobed, ± 3 mm long; corolla campanulate, deeply 4-lobed, ± 5 mm long, pale cream-coloured to pinkish white, appressed hairy on back; stamens 8, narrowly ovate, ± 3 mm long, anther thecae pubescent on outer surface. *Female flowers*: calyx not accrescent, persistent in fruit, 4-lobed, ± 2 mm long; corolla 4-lobed, ± 4 mm long, green, lobes appressed hairy on back; ovary hairy, borne on a fimbriate, fleshy disc; styles 2. *Fruit* an indehiscent, globose berry, ± 9 × 10 × 8 mm, densely appressed hairy; young fruits green, ripening through brownish red to purplish black. *Flowering time*: October to January. *Fruiting time*: November to February. Figure 2.

TABLE 1.—Distribution of seven species of *Euclea* according to quarter-degree grid squares of SCPE

Euclea species/infraspecific taxa	2429BC	2429BD	2429DB	2429DD	2430AC	2430CA	2430CB	2430CC	2430CD	2529BB	2529BD	2530AA
E. crispa subsp. *crispa*		•	•	•		•	•	•	•	•	•	•
E. divinorum		•	•		•	•	•	•	•			
E. linearis		•		•	•	•	•	•	•	•		
E. natalensis subsp. *angustifolia*					•	•			•	•	•	
E. schimperi var. *daphnoides*					•	•		•				
E. schimperi var. *schimperi*		•			•							
E. sekhukhuniensis		•				•	•	•		•		•
E. undulata	•	•	•	•	•	•	•	•	•	•		
Total	1	6	3	3	6	7	5	6	5	5	2	2

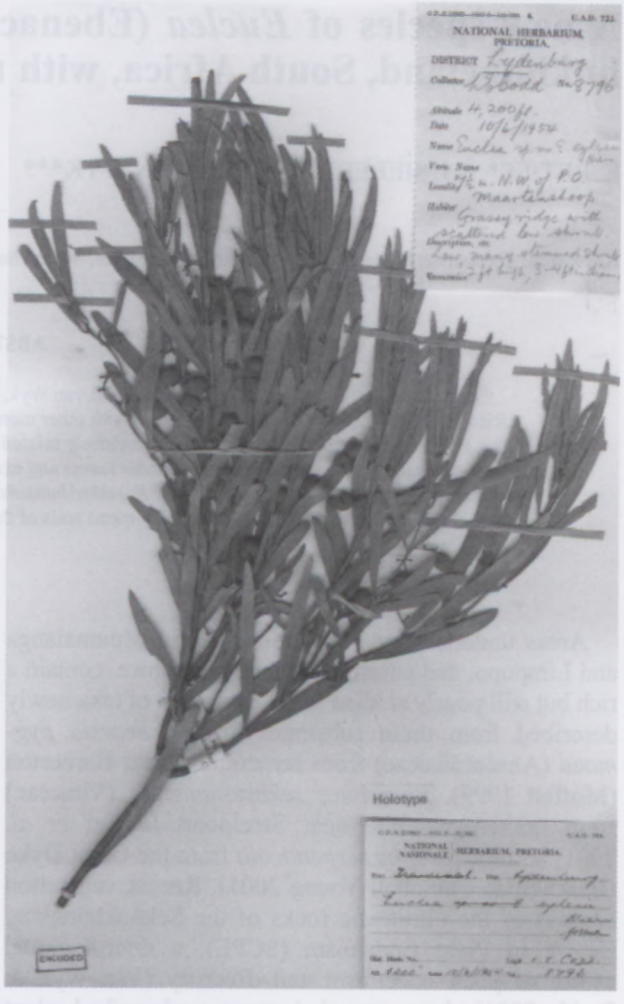

FIGURE 1.—*Euclea sekhukhuniensis*, *Codd 8796*, holo. (PRE).

Diagnostic characters: members of *Euclea* can be divided into two groups (De Winter 1963): 1, species with the corolla shallowly lobed at the apex; and 2, species with the corolla cleft at least halfway down or more. All the *Euclea* taxa occurring in the SCPE belong to the latter group. *E. sekhukhuniensis* and *E. linearis* are dis-

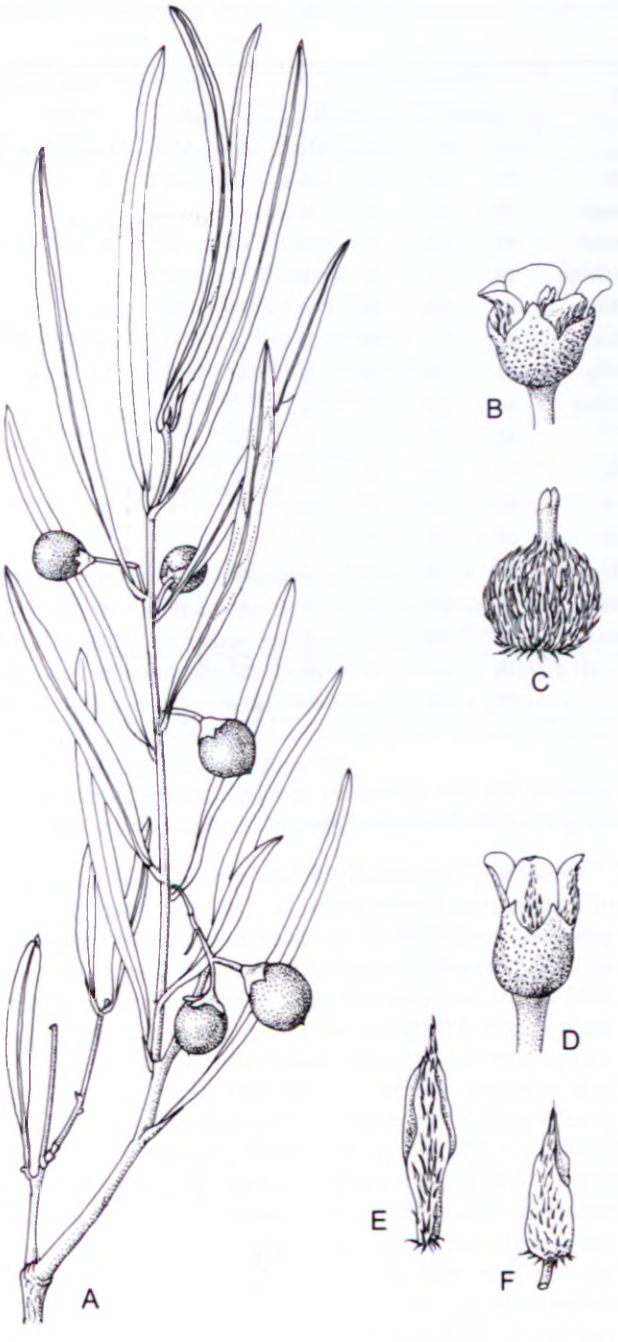

FIGURE 2.—*Euclea sekhukhuniensis*, *Plant Specialist Group 4* (PRE). A, fruiting branch, × 0.75; B, female flower, × 3.8; C, gynoecium, × 7.5; D, male flower, × 3.8; E, stamen of outer row, × 7.5; F, stamen of inner row, × 7.5. Artist: G. Condy.

tinguished from the others by their narrowly oblanceolate-elliptic to linear or linear-falcate leaves and young leaves and twigs that are covered with a granular, rust-brown exudate. *E. sekhukhuniensis* is most closely related to *E. linearis*; however, *E. sekhukhuniensis* is a gregarious, evergreen geoxylic suffrutex (White 1977), whereas *E. linearis* is a shrub or tree up to 5 m high. Leaves of *E. sekhukhuniensis* are straight, broader and longer than the sickle-shaped leaves of *E. linearis* and its fruits are larger than those of *E. linearis* (Table 2).

Conservation status: *Euclea sekhukhuniensis* has a restricted geographical range within which it is locally fairly common (Figure 3). However, some of its habitat is under immediate threat of rapid urbanization as a result of increased mining activities in the greater Steelpoort River Valley and the construction of the De Hoop Dam on the Steelpoort River. *E. sekhukhuniensis* is not formally protected in any conservation area. Populations of this species should therefore be closely monitored and a Red Data List assessment of this species prioritized. Its conservation value is considered relatively high, as it could possibly be used in the rehabilitation of mine dumps due to its internal mechanism of excluding heavy metals.

Ecology and speciation: both *Euclea sekhukhuniensis* and *E. linearis* occur on vegetation anomalies—sparsely vegetated soils that are mineralized (Table 3). This phenomenon is well reported for populations of *E. linearis* in wooded grassland on the serpentinites of the Great Dyke in Zimbabwe (Wild 1965). A distant outlier of what has been identified as *E. linearis* is also found on grassy ridges in fynbos in a limited area in the Calvinia and Vanrhynsdorp region of the Western Cape, where it grows on nutrient-poor soils derived from sandstone of the Table Mountain Group (White 1983). However, the identity of these plants requires verification. In the mountainous regions of the northern provinces of South Africa, *E. linearis* grows on rocky outcrops and in dry woodlands on slopes and in valleys of serpentenite (Barberton Supergroup) in the Barberton region, acidic sandstone (Waterberg Group) of the Waterberg of Limpopo, and quartzites (Black Reef Formation) along the northeastern Drakensberg Escarpment (White 1983). Thus, it appears that *E. linearis* tends to colonize habitats with harsh soil conditions in mountainous regions (acidic, nutrient poor and/or rich in heavy metals).

Euclea sekhukhuniensis appears to be an example of incipient sympatric speciation due to ecological interactions in a new habitat in which restricted gene flow has evolved through selective reproduction between individuals of *E. linearis* that are adapted to a specific ultramafic substrate. This speculation is supported by the work of Alados *et al.* (1999), which demonstrates that asymmetry and within-plant variance were higher between specimens of the same species in the contact zone between ultramafic and normal soils. In the SCPE, habitat preference has resulted in the two *Euclea* species

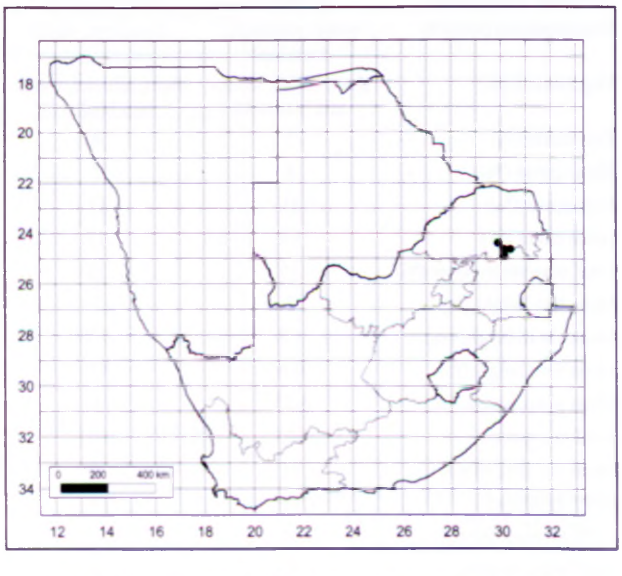

FIGURE 3.—Known distribution of *Euclea sekhukhuniensis*.

TABLE 2.—Leaf and fruit measurements of 15 *Euclea sekhukhuniensis* specimens and only results of 30 randomly selected specimens of *E. linearis* from Mpumalanga and Limpopo (all in PRE)

No.	Collector no., herbarium	Grid	Locality	Mature leaf (mm)				Mature fruit (mm)			
				Length		Width		Length		Width	
				Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1.	*Herman 793* (PRE)	2430CB	Burgersfort	55	27	6	4	11	9	9	8
2.	*Van Wyk, Siebert & Retief* 13204 (PRU)	2430CC	Frischgewaagd	76	19	6	4	-	-	-	-
3.	*Siebert* 411 (PRU)	2430CC	Frischgewaagd	81	22	7	4	10	9	9	8
4.	*Barnard & Mogg* 1031 (PRE)	2429BD	Leolo Mountains	89	31	9	5	-	-	-	-
5.	*Wright G14* (PRE)	2430CA	Maandagshoek	80	26	8	5	11	9	10	9
6.	*Kritzinger 138*(PRE)	2430CA	Maandagshoek	80	22	10	6	10	-	10	-
7.	*Codd 8796* (PRE)	2430CC	Maartenshoop	81	39	10	5	8	7	7	6
8.	*Siebert 938* (PRU)	2430CC	Olifantspoortjie	85	19	6	3	-	-	-	-
9.	*Van Wyk 13299* (PRU)	2430CC	Steelpoort	62	21	7	5	10	9	9	8
10.	*Van Wyk 13035* (PRU)	2430CC	Thornecliffe	75	23	7	3	9	8	8	7
11.	*Van Wyk 13036* (PRU)	2430CC	Thornecliffe	82	20	7	4	12	9	10	9
12.	*Van Wyk & Siebert 13312* (PRU)	2430CC	Thornecliffe	60	19	7	2	-	-	-	-
13.	*Van Wyk & Siebert 13313* (PRU)	2430CC	Thornecliffe	76	23	9	4	10	8	9	7
14.	*Plant Specialist Group 4* (PRE)	2430CC	Thornecliffe	86	22	7	4	11	8	8	7
15.	*Siebert 934* (PRU)	2430CC	Tweefontein	68	18	12	5	-	-	-	-
	Euclea sekhukhuniensis mean measurement (15 specimens)			76	23	8	4	10	8	9	8
	Euclea linearis mean measurement (30 specimens)			52	28	2.5	1.8	5.9	-	5.4	-

now growing in specific, but different habitats in association with specific plant species (Tables 3, 4). According to Dieckmann & Doebeli (1999), theoretical evidence suggests a prominent role for ecologically driven speciation in sympatry. Hence, the present study supports the opinion that the ecological species concept is an essential part of the biological species concept (Grant 1992).

TABLE 3.—Environmental, structural and floristic characteristics unique to plant communities dominated by either *Euclea sekhukhuniensis* or *E. linearis* in Steelpoort River Valley

Characteristics	*E. sekhukhuniensis*	*E. linearis*
Slope (°)	4 (0–9)	3 (1–5)
Aspect	S, N	S, W
Rock cover (%)	45 (25–70)	40 (10–80)
Rock size (mm)	465 (100–1 500)	225 (50–500)
Soil type	Glenrosa, Valsrivier	Bonheim, Steendal, Valsrivier
Geology	pyroxenite, norite, magnetite	alluvium, pyroxenite, gabbro
Chemical composition	calcareous	brackish (sodic)
Topographical position	scarp, midslope, footslope	footslope, valley
Vegetation type	short, rocky, mountain bushveld	short, alluvial, mountain bushveld
Tree cover (%)	3	4
Shrub cover (%)	8	7
Forb cover (%)	11	11
Grass cover (%)	13	17
Total vegetation cover (%)	35	39
Mean tree height (m)	3	3
Mean shrub height (m)	1.7	1.8
Mean forb height (m)	0.6	0.6
Mean grass height (m)	1.25	1
Total no. species	105	96
Mean no. species/site	44	42
SCPE endemics	14	14
SCPE near-endemics	9	10
Red Data List taxa	4	4

Generally, ecologically driven speciation is the result of habitat-specific preferences. This has been investigated and confirmed for an endemic species of *Impatiens* and its widespread congener (Chung & Kang 1996), as well as for two endemic species of *Dicerandra* of the same region (Menges *et al.* 1999). In the case of *Euclea sekhukhuniensis*, an open niche with an anomalous Ca-rich substrate (14.68% = 146 800 ppm) in an otherwise typical environment of brackish soils rich in Mg (19.97% = 199 700 ppm), probably favoured speciation (Figure 4A). Similar trends have been perceived between especially limestone (Ca-rich) and sandstone, once again for an endemic and its widespread congener (Walck *et al.* 1999), as well as two endemics of the same region (Mustart *et al.* 1994). Like limestone, the soils inhabited by *E. sekhukhuniensis* are Ca-rich (1.95Ca:1Mg), more than double that of the soil substrate of *E. linearis* (Figure 4A). Furthermore, soils in which *E. linearis* grows have higher concentrations of total Cr and Ni (typical elements of serpentinite) (Figure 4B), with high Fe, Si and Mg levels (1Mg:0.34Ca) (Figure 4A), and it accumulates relatively high concentrations of Al and Fe in its roots (Figure 5A). *E. sekhukhuniensis* accumulates lower levels of Fe in its roots, but with higher concentrations of Cr and Ni than *E. linearis*, although these levels are very low and not regarded as hyperaccumulation (Figure 5A). Overall, it seems that *E. sekhukhuniensis* is the better excluder of heavy metals, when considering the high concentrations of metals in the associated soil.

It is suggested that *Euclea sekhukhuniensis* was an ecotype of and has developed from *E. linearis* as a result of the genetic properties of the latter to adapt to and colonize ultramafic soils such as those derived from serpentinite (Wild 1974). It is hypothesized that *E. sekhukhuniensis* is a 'soil-adapted' neo-endemic which speciated

TABLE 4.—Prominent taxa recorded for communities dominated by either *Euclea sekhukhuniensis* or *E. linearis* in Steelpoort River Valley (Siebert *et al.* 2002b)

Life forms	Species dominant in:		
	Euclea sekhukhuniensis dominated community	*Euclea linearis* dominated community	Both communities
Grass layer	*Heteropogon contortus*	*Andropogon chinensis*	*Brachiaria serrata*
	Tristachya leucothrix	*Fingerhuthia africana*	*Diheteropogon amplectens*
	Setaria sphacelata	*Loudetia simplex*	*Themeda triandra*
Forb layer	*Rhynchosia spectabilis*	*Dicoma gerrardii*	*Berkheya insignis*
	Orthosiphon fruticosus	*Petalidium oblongifolium*	*Gnidia caffra*
	Jamesbrittenia macrantha	*Rhynchosia komatiensis*	*Phyllanthus glaucophyllus*
Shrub layer	*Elephantorrhiza praetermissa*	*Grewia vernicosa*	*Brachylaena ilicifolia*
	Diospyros lycioides subsp. *nitens*	*Searsia keetii*	*Tinnea rhodesiana*
	Hippobromus pauciflorus	*Searsia wilmsii*	*Vitex obovata* subsp. *wilmsii*
Tree layer	*Catha edulis*	*Bolusanthus speciosus*	*Acacia caffra*
	Cussonia transvaalensis	*Combretum hereroense*	*Euclea crispa* subsp. *crispa*
	Faurea saligna	*Protea caffra*	*Lydenburgia cassinoides*

recently, after the Pleistocene (Reeves *et al.* 1983), and has not yet had the time or routes to migrate out of the Steelpoort River Valley. However, it is doubtful whether this will ever happen, as the species probably prefers the open niches of ultramafic soils where it has a physiological mechanism associated with high plant levels of Ca to tolerate heavy metals (Figure 5B).

Specific epithet and common names: the specific epithet refers to the geographical area where the species is endemic. Sekhukhuneland is traditionally inhabited by the Pedi (Mönnig 1967) and is currently under the reign of K.K. Sekhukhune (Paton 1998). Common names for the taxon include *moshigwane* (Northern-Sotho), Steelpoort guarri (English) and *Steelpoortghwarrie* (Afrikaans).

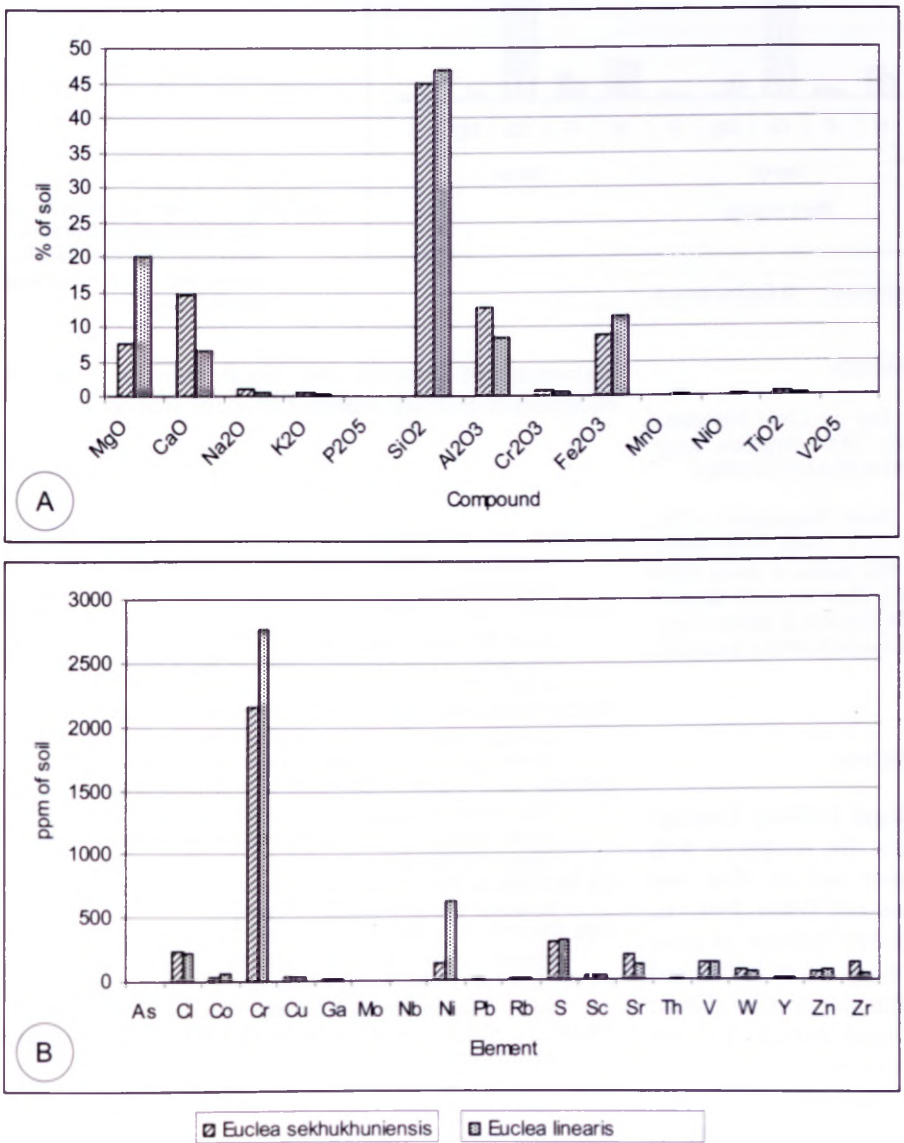

FIGURE 4.—Chemical analyses of five soil samples collected from root zone (300 mm deep) for each of *Euclea sekhukhuniensis* and *E. linearis*.

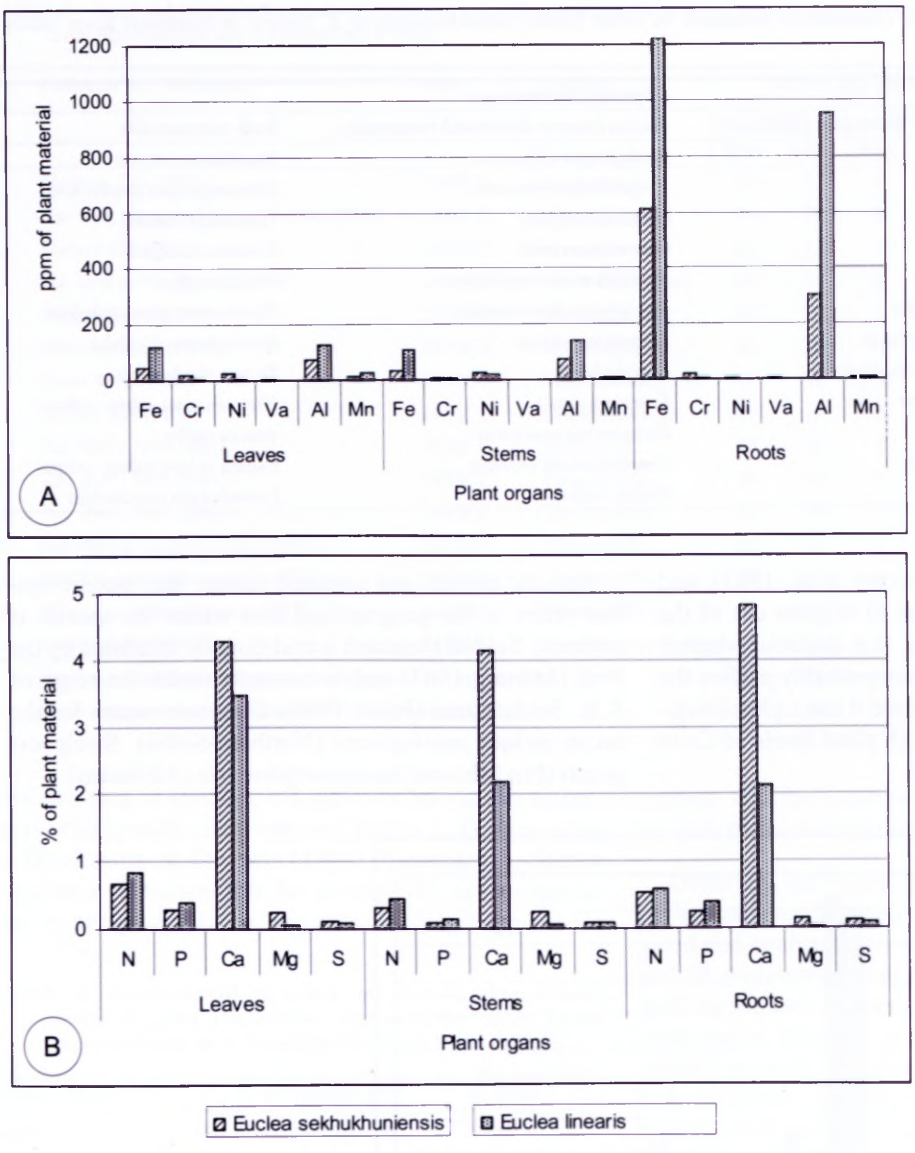

FIGURE 5.—Chemical analyses of plant material from five individuals each of *Euclea sekhukhuniensis* and *E. linearis* (young and old growth).

SPECIMENS EXAMINED

LIMPOPO.—2429 (Zebediela): Het Fort on Leolo Mountains, (–BD), *Barnard & Mogg 1031* (PRE). 2430 (Pilgrim's Rest): Maandagshoek, (–CA), *Kritzinger 138* (PRU), *Wright G14* (PRE).

MPUMALANGA.—2430 (Pilgrim's Rest): Burgersfort, (–CB), *Herman 793* (PRE); Maartenshoop, (–CC), *Codd 8796* (PRE); Frischgewaagd, (–CC), *Siebert 411, Van Wyk, Siebert & Retief 13204* (PRU); Thornecliffe Chrome Mine, (–CC), *Plant Specialist Group 4* (PRE), *Siebert 934, Van Wyk 13035, 13036, Van Wyk & Siebert 13312, 13313* (PRU); Olifantspoortjie, (–CC), *Siebert 938* (PRU); Steelpoort, (–CC), *Van Wyk 13299* (PRU).

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